Playing with the Highway Experience

Pervasive Games on the Road

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Abstract

We explore how the dynamic and vivid context of road travel, i.e. the highway experience, can be used to provide drama and challenge to pervasive games. The aim has been to gain insights into this novel application area and to understand the potential and implications for design. The thesis embraces a design-oriented research approach, where knowledge has been gained through the process of designing, implementing and evaluating experimental prototypes. The research has resulted in three prototypes, i.e. Backseat Gaming, Road Rager and Backseat Playground, which in various ways illustrate the potentials and problems in the proposed design space.

Backseat Gaming makes use of roadside objects to create a contextualised game experience as the player travels along a specific route. The intention with the prototype has been to explore the characteristics of the fictitious linkage between the game and road-context. We have particularly looked at what types of roadside objects that could be integrated to create an understandable and engaging pervasive game. Road Rager is a multiplayer game where children that meet in traffic duel against each other. We suggest that the temporal and unpredictable character of an encounter, as well as the proximity, can provide for interesting game-play. A critical challenge is to enable multimodal interaction when the lifetime of a game-event is very limited. The Backseat Playground is a murder mystery game, which takes place in the physical landscape outside the window of the vehicle. The prototype particularly explores the prospect of automatically scaling the game to vast geographical areas through integration with digital maps. Additionally, it explores how to provide sequential storytelling that fits with the journey through the landscape. We will hereafter refer to these types of games as *journey games*.

In this thesis we will explore four issues, which we argue are of crucial significance when designing experiences, which combine pervasive game play with the highway experience. First, we will tease out what parts and types of a digital game that fits with this experience. Second, we will look at ways to design the game interface so that the player's can

combine a visual attention on the road-context with game play. Then, we will investigate how to utilize the passengers' cursory experience of the swiftly passing road objects. Finally, we look at how to provide game-content, which match to the temporal unfolding of the surrounding road-context.

Keywords: Journey, cursory, pervasive games, experimental prototyping, experience design, interaction design, location based, context aware applications, highway experience.

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Part 1

Playing with the Highway Experience

Preface

Agent Bravo and the gunfire

August tries to calm down. He takes a deep breath and his little fingers quickly whisk away a wisp of hair that has fallen down in his face. He knows they are out here somewhere; they must be. The car he is sitting in gently moves through the rural landscape, quickly passing woods and big open fields. He gazes out through the side window of the backseat and tensely sweeps the directional microphone back and forth, but nothing, not a sound except a couple of birds and an obstinate bee. The road to grandma is usually no more exciting than this. There are always the same anonymous houses and endless rows of boring trees. This time it is different. The device he holds in his hand is one of those clever apparatus specially customized for the countries secret force of top agents. If you push the button it transforms itself into an, for the occasion, appropriate tool.

He tensely sweeps the directional microphone back and forth … (photo: ©Anton Gustafsson)

A sharp ring tone suddenly breaks the silence. August looks down at the device. It is Helena calling from headquarters. He quickly accepts the phone call and Helena's voice fills the air.

- Agent, the blood report from the attempt to catch the wolf is very odd. The blood is human. We are going to have to keep this quiet, but the boss expects a full explanation. I've tried to calm him down but he is like a wild animal. He isn't pleased. I send you a report.

She abruptly hooks up the phone. August takes a minute to look at the text that shows up on the device. It's the results from a blood test. The blood had been sent to the laboratory by one of his field-agents. It was the only evidence they had managed to secure from an earlier attempt to catch a wolf. "That's weird" he mumbles to himself. He had been so sure. He definitely perceived the sound of a wolf as he passed through that deep forest earlier on. "I better be more careful with my commands. We might end up in big trouble", he ponders.

The car slows down as the road turn and passes right through an old farm. He looks out to his left where tree cows are peacefully chewing the afternoon meal and he quickly aims the directional microphone towards an old barn that appears behind the crest. But he can only hear a couple of chuckling hens. The crackling sound of the walkie-talkie suddenly starts and agent Bravos voice is heard over the line.

- Boss, I just saw your car passing by. We are here at the farm looking for the robbers. Locals here have seen some suspicious people snooping around. Over!

The sound from the walkie-talkie stops. August looks intensely at a huge round silo that passes outside the windscreen. All of a sudden, a deafening gunshot is heard. He quickly aims the directional microphone towards the silo. His heart beats faster. "They must be in there ..."

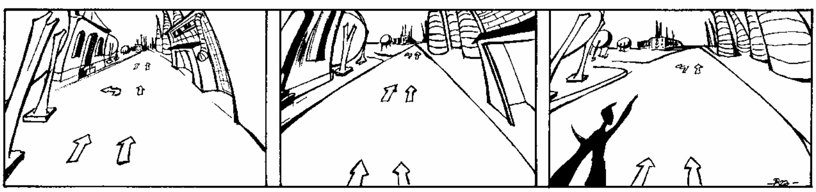

Illustration: Åza Mårtensson

The above text is a fictive story, based on the actual game content and interaction technologies of the Backseat Playground prototype. It illustrates a possible scenario for a Journey game that will be discussed in this thesis. More specifically, it illustrates the potential of using the dynamic and vivid context of road travel to provide drama and challenge to pervasive games. The continuing text will present the concept and our research into the prospect and challenge of creating this novel kind of experiences.

Chapter 1

Introduction

Travelling along a road conveys a continuous flow of impressions and new situations where changing scenes, sense of motion and contingent encounters provide for a very special experience (Appleyard et al, 1964). It can be seen as a sequential experience, resembling a dramatic play of space and motion, also referred to as the *highway experience*. This thesis explores the possibility of using the dynamic and vivid context of road travel to provide drama and challenge to pervasive games, referred to as *journey games.*

The target group for the research is children, who travel in the backseat of cars. A driver, which constantly has to focus on the driving and other activities on the road, is limited to watch the road scenario in a narrow forward angel. A passenger on the other hand is free to study the whole scenario in more detail and can enjoy the journey by looking out through the windows. However, traveling in a vehicle entails an obligation to sit still, sometimes for an undecided period of time. This extended period of physical inactivity is often perceived as being boring, especially by children. Instead, children often engage in different means of amusement in order to pass the time. They might read, talk or play games. However, available computer generated games are often exclusively screen-based. Thus, this form of traditional computer game rather obscures the highway experience, than exploit it for fun, exploration, play and creativity. Besides, to focus exclusively on a screen or a book easily leads to nausea. The possibility to incorporate different aspects of the journey to create engaging experiences is therefore a promising alternative.

Transporting oneself to different destinations is today an important part of most people's mobile life. For many children it is a mundane activity involving daily commuting to school, trips to the local supermarket, to visit friends or going to different recreational activities. The week-ends might include trips to the seaside; to the holiday cottage, or to visit the grandparents living in the next town. During holiday many children spend considerable time in a vehicle on longer journeys to far reach destinations. The statistic shows that people in U.K. spend an average of 3309 km per person per year (2002/2003) as a passenger in a car or a van (DFT, 2005). This distance is equivalent to an average of 228 trips and approximately 82 hours of traveling per person and year. Even children younger than five years old travel in a vehicle as much as 45 minutes per day (Hu & Reuscher, 2004).

This thesis map out and explore a design space, consisting of pervasive games and the highway experience of a passenger in a moving vehicle such as a car. The aim is to gain insights into this novel application area and to understand its implications for design. The work is conducted within a research agenda called "the interactive road - enhancing the experience of road use", which has been pursued by the Mobility studio at the Interactive Institute in Stockholm since 2001 (Juhlin, 2005). It explores the benefits of increased interaction between individual drivers, and road users in general, to create innovative services and corresponding technology. It recognises that the highway is used, apart from transportation, as a place of work and mobile experiences. The research agenda has resulted in a range of prototypes and studies related to road-use (Juhlin, 2005; Esbjörnsson, 2005; Normark, 2006; Östergren, 2006). This thesis further contributes to research on pervasive games and mobile human computer interaction. The contribution is of three kinds, that is a theoretical design framework, a set of experimental prototypes and design insights based on user trials. We argue that the design challenge of combining pervasive games with the highway experience especially raises five issues, namely how to:

- Map game theory to journey experience
- Enable interaction with road objects
- Create experiences based on road objects
- Match game-content to the temporal unfolding of the surrounding road-context
- Account for traffic safety

The identification of this set of issues emerges out of architectural research on the highway experience as well as the growing body of games research. From a games research perspective, this thesis explores various aspects of games and gaming. It draws on theories in ludology (Frasca, 1999), in the sense that it differentiates in between game play and storytelling, or in between configuration and interpretation (Eskelinen). Thus, a key topic is to investigate how those aspects of game play fits with being a passenger. Furthermore, early architectural theory on the highway experience has been influential in framing the research issues. A passenger apprehends the external road-context primarily through visual sense, framed by the window of the vehicle (Appleyard et al, 1964). The vehicle's body of steel filters out a lot of stimuli, such as hearing, touch and smell, from the external environment. Furthermore, it is moving in high speed through the landscape, which makes it only possible to catch brief glimpses of objects and actions on and beside the road. Accordingly, a passenger misses out on much detail of the local context and gains a rather shallow apprehension of the roadside (Juhlin & Normark, 2006). In this thesis we will use the term *experience* when discussing passengers' apprehension of the road-context. Due to the passenger's superficial apprehension of the roadside we will refer to this experience as *cursory*. When designing pervasive games for the road, where fictitious content is linked with the physical world outside the vehicle, it is significant to account for the cursory experience of the road-context. The player must be able to both understand the linkage and find it believable and meaningful as part of a game, even though the road-context is quickly passing by. In this thesis we explore the possibility to provide a playing passenger with an imaginative fiction, while we simultaneously draw upon the locality of the surrounding road-context. Hence, we make use the everyday meanings of objects, and make the fiction fit with them. We will refer to this design approach as *twisting* the link between the geographical objects and the game. The swift movement through space, which gives little time at an individual road object, raises concerns regarding the ways in which the player should interact with the computer, without loosing sight of the physical landscape. Traditional screen-based interaction risks having the player focusing solely on the computer interface, rather than looking out through the windows, and thus spoils the specific benefits of the highway experience. Accordingly, this thesis explore the possibility to enable and balance the player's engagement between computer and the external surrounding, when the time for identification and interaction is very restricted and still provide a game which is engaging, interesting and challenging.

Further, due to the unpredictability of the passenger's progression through the road-network, a major challenge concerns the possibility of using the journey as it unfolds in real-time through the physical landscape. We are here concerned with how the game can be distributed in the physical landscape and how game-content can be matched to the temporal unfolding of the surrounding road-context. Finally, it is essential to account for traffic safety when designing a game for use in a moving vehicle. A design which challenges safety, by for example distracting the driver, could lead to lethal consequences. Regardless, this issue has been marginally addressed within this thesis. However, we will still articulate the ways in which they have been accounted for in this research.

The research has been conducted through the design, implementation and user trials of three prototype games, which in various ways maps out the design space. The prototypes are called *Backseat Gaming*, *Road Rager* and *Backseat Playground*.

Backseat Gaming makes use of roadside objects to create a contextualised game experience. The link between digital game events and geographic locations are manually created along a specific route. The study of Backseat Gaming investigates the characteristics of the connection between the game and roadside objects to create an understandable and engaging pervasive game on the road.

Road Rager is a multiplayer game where children, who meet in traffic, duel against each other. It is based on ad-hoc peer-to-peer networking, which connects the players when being in each other's proximity. We suggest that the temporal and unpredictable nature of an encounter, as well as the proximity, provide for meaningful game-play. The study focuses especially on how to afford interaction with the computer when the life span of passing a geographical object is very limited.

The Backseat Playground prototype is developed to explore the prospect of automated geographical scalability of the game, which includes being able to unfold stories with local references that make sense for all possible travel paths through the road-network. The prototype makes use of available digital maps to automatically associate roadside objects and places along the roads.

Chapter 2

Games research

The thesis is influenced by game related research. Based on our reading of this emerging research field, we suggest that it can be divided into two different areas, i.e. theoretically-oriented games research and design-oriented games research. Theoretically-oriented games research aim at understanding the phenomenon and impact of games and game-play from an analytical perspective. It draws on disciplinary knowledge from a range of research fields, such as comparative literature, film studies, theatre studies, graphic design, game design, psychology, anthropology, cognitive science, cultural studies, philosophy, economy and sociology. These fields contribute with their own set of methodologies and theoretical perspectives to gain an understanding of games and game-play (Heide-Smith, 2002; Bryce & Rutter, 2006). Design-oriented research refers to studies, which include innovation, design, and construction of novel kinds of information and interaction technology to gain new knowledge (Fallman, 2003). In line with Fallman we will in this thesis refer to this way of conducting research related to games as design-oriented games research. In the following, we will give an overview of the history and current practise within these two research strands.

Theoretically-oriented games research

Theoretically-oriented research on digital games emerged as field around the turn of the millennium, according to Juul (2005). Accordingly, an abundance of conferences, peer-reviewed journals, magazines, university courses and web-sites devoted to the study of digital game appeared. Common research topics embrace social and cultural issues of digital games, such as effects of games on social behaviour, as well as the meaning and significance on gender, identity, ideology and communities on gaming. Other common research topics focus on the study of digital games from an aesthetic perspective and on games ‘in themselves’. This include first-person experience of playing games, games as art, visual aspects and interactivity as well as definition and structure of digital games and the ways in which time, space and narrative are represented.

The area has a history in the study of non-electronic games. During the whole 20th century non-electronic games where studied for many different purposes and the concept of games where applied to diverse areas as linguistics, mathematics, economics and the understanding of human problem solving (Juul, 2005). There were also several studies conducted with the agenda of understanding games for their own sake. In the 1930's the Dutch anthropologist Johann Huizinga wrote an influential book where he introduce the term "homo ludens", meaning "Man the player" (Huizinga, 1955). Huizinga argues that it is human nature to play and that it is a part of life. He further claims that it serves as a way to free our mind from a tedious every day life, and also gives us an opportunity to inspire our realities in interesting ways. According to Huizinga play is:

> *[A] free activity standing quite consciously outside "ordinary" life as being "not serious," but at the same time absorbing the player intensely and utterly. It is an activity connected with no material interest, and no profit can be gained by it. It proceeds within its own proper boundaries of time and space according to fixed rules and in an orderly manner. (Huizinga, 1955, pp. 13)*

The importance of play is visible everywhere in our society. We arrange performances and competitions. We build sites devoted for play such as playgrounds, swimming pools, arenas, racetracks and amusement parks. We even invent a wide variety of equipment in order to expand the opportunities, places, and time that we can play (MacLean, 2006). Paul D. MacLean, a leading neuroscientist specialized in brain evolution and behaviour, claimed that play is of evolutionary importance for survival, learning, and socialization. However, play is not specific for human kind but rather a characteristic for mammals in general. MacLean noted that unlike reptiles, mammals have a neutral instinct and ability to play. For most animals play is the same thing as to learn, they play to develop their skills and they often play throughout their lives (MacLean, 2006). This was also pointed out by Huizinga:

> *We have only to watch young dogs to see that all the essentials of human play are present in their merry gambols. They invite one another to play by a certain ceremoniousness of attitude and gesture. They keep to the rule that you shall not bite, or not bite*

> *hard, your brother's ear. They pretend to get terribly angry. And-what is most important-in all these doings they plainly experience tremendous fun and enjoyment. (Huizinga, 1955, pp. 9)*

Given the ubiquitous presence of play in society, it is not so surprising that the new digital technology was adapted for this particular purpose. In the beginning of the 1970s commercial games for arcade machines and video game consoles got introduced and available for the general public (Winter, 1996). During the end of the 1970s and beginning of the 1980's they gained great popularity, which contributed to public debates on potential harmful effects. Digital games now became a theoretical research topic within academia where psychologists and sociologists attempted to map behavioural effects of game-play (Heide-Smith, 2002). Questions concerning their influence on e.g. addiction and learning, were now of interest. During the 1990's the study of digital games became of interest for a range of other academic research disciplines applying their own theories to the field. The two most visible approaches are narratology and ludology.

Narratology is based on the use of "*narrative and literary theory as the foundation upon which to build a theory of interactive media" (Mateas, 2002).* The narrativists "claim that games are closely connected to narrative and/or that they should be analyzed –at least in part– through narratology" (Frasca, 2003). Thus, they look at games as a storytelling medium. The term *Ludology* refers to "the study of games" (Juul, 2005). It gained acceptance around 1999 after a publication by Gonzalo Frasca (Frasca, 1999). Spokesmen for Ludology advocated for a separate academic field with the aim of studying games for their own specific characteristics, rather than seeing them simply as stories. One of the earliest supporters of Ludology is the finish game theorist Markku Eskelinen. Eskelinen argues that the dominant user function in games is configurative, or manipulative, rather than interpretative as in e.g. literature, theatre and film (2001). A film or a novel exist in its own right and doesn't change its plot dependant on the viewer. A game on the other hand is dependant on the player's active engagement in order to evolve in real time. Manipulation refers to how the player can configure or change the game world in different ways. But he also argues that a game world can potentially be interpreted and explored. Interpretation implies the players' understanding and conception of the game world. Exploration refers to the players' experience of moving around within the game and the ways in which they investigate the space. The influential game theorists Katie Salen and Erik Zimmerman (2004) also emphasises the role of configuration in games. According to them, the player needs to make choices and take actions within the game-system and every action taken should result in a change influencing the overall system of the game. They give the following definition of a game:

> *A game is a system in which players engage in an artificial conflict, defined by rules, that results in a quantifiable outcome. (Salen & Zimmerman, 2004, pp. 80)*

Thus, a game is experienced by players that actively engaged with the system. A central characteristic to games are conflict, i.e. a contest of powers. This contest can be against the game system or against other players, and can be cooperative or competitive by nature. This conflict is furthermore defined as artificial, which means that it is separate from our so-called "real life". The most crucial characteristic of a game is its rules. Rules are what define the game and limit what can be done by the player during game play. According to Huizinga the rules of a game are absolutely binding and allow no doubt (Huizinga, 1955). All games also need to provide a quantifiable outcome, through which the player at the end of the game can decide whether she is winning or loosing. According to Salen and Zimmerman quantifiable outcome is what usually distinguishes a game from less formal play activities (2004).

Summing up, games research, and especially Eskelinen's early distinction between configuration and interpretation, in the area of theoretically-oriented games research, has been of specific importance for framing the research in this thesis. It has been important in focussing on game play experiences per se. However, we have chosen an eclectic position in the discussion between narratology and ludology. For us, games can be more or less configurative or interpretative, or in other words, provide more or less manipulative challenges or stories.

Design oriented games research

Research that focus on design and exploration of novel game experiences with the help of digital technology has its origin back in the 1950s and 1960s, adjacent to the birth of the first computer games. At that time computers were exceedingly expensive, which meant that mostly university mainframes were able to run a game. The earliest graphical computer game known to exist is OXO created by Douglas in 1952 at the University of Cambridge (Bryce & Rutter, 2006). Douglas created the game in order to demonstrate his research on human-computer interaction. It was a graphical version of tic-tac-toe where the player competed against the computer. The first widely available and influential computer game is generally considered to be “Spacewar!” developed in 1961 by three institute fellows at MIT, i.e. Wayne Witanen, J. Martin Graetz and Stephen R. Russell. It is a two-player game where the players’ can manoeuvre a spaceship while fighting the gravitational pull of the sun. The player can score by firing missiles at his opponent (Graetz, 1981).

We will in the following specifically discuss an area of design oriented games research, which has a similar interest to the research formulated in this thesis, i.e. to mix virtual content with the experiences of real-life. The merge between imaginative non-digital game-play and real-life properties, such as physical objects, our sense of space or face-to-face communication, has existed in traditional games long before the computer was invented (Magerkurth et al, 2005). Games, where the physical surrounding plays a crucial part, are also a popular and prevalent social activity during car journeys (Jepson, 2006). These games often involve game-play where the player looks for specific objects along the road. It might for example involve the task of counting cars of a specific colour or to play “I spy with my little eye”. However, new possibilities emerge by combining computer-generated experiences with the experience of physical environments. According to Magerkurth et al, (2005) computer games have some advantages over non-digital games that make them more popular than traditional games. First, computers are able, by the help of different media, to generate experiences that can engage a player in an imaginative world. Second, the goals of computer games are typically more interactive than that of traditional games, which brings players a stronger desire to win. Third, computer games provide an optimal level of information complexity, which can spark players’ curiosity. However, the players might become too mentally involved in the game and the screen of the device, and hence missing out on the experience of real life. (Magerkurth et al, 2005). By merging the power of computer generated game content with the setting of many traditional games, entirely new kinds of experiences can be created, which has the potential to embrace the players own physical, social and cultural real-life situation. The attempt to create games that mix virtual content with our physical real-life domain is today a widespread research topic and has been visible within academic research since the late 1990's. There are a number of different terminologies that relate to these kinds of games. In the following text we will present the terms that has been of relevance when writing this thesis, i.e. *augmented reality games, mixed reality games, pervasive games*, *location based games and tangible games*.

Augmented Reality Games

The term Augmented Reality (AR) was coined in the early 1990's by researchers at Boeing Corporation (Höllerer & Feiner, 2004). It refers to applications where computer graphics are superimposed directly upon real world environments. Virtual 3D objects are adapted and presented in such way that they are perceived to exist in physical space. Azuma (1997) defines Augmented Reality as real time systems that combine real and virtual, and that are registered in 3-D. Augmented reality is often presented by means of see-through head-mounted displays, but can also be realised by projecting images on real-world surfaces or by the help of hand-held devices (Magerkurth et al, 2005). There are several projects that propose the use of augmented reality to enhance existing games (Nilsen et al, 2004). ARQuake (Thomas et al, 2000) and Human Pacman (Cheok et al, 2003) are examples of AR-games that superimpose graphics directly upon the real world using a see-through head-mounted display. The systems allow the user to walk around in a demarcate area outdoors to play the game. ARQuake seeks to map the traditional game Quake onto a campus area (Thomas et al, 2000). Similarly, Human Pacman augments the physical space with the game Pacman (Cheok et al, 2003).

At the same time as the possibility of superimposing computer graphics directly upon the real world environment provides great potential for creating a merged experience, it also entail a great challenge in a road-context. A key area in augmented reality research deals with the accuracy of the overlay (Azuma, 1997). Calibration errors and lags in the system easily contribute to a mismatch between the two worlds, especially when the viewpoint or the object is moving. This problem is even more salient when travelling in a vehicle, where the spatial relations are in flux and the temporal relations are very brief. Therefore, we explore other means to provide something of an AR-experience, even though we do not attempt to increase the technical accuracies of the techniques.

Mixed reality games

Mixed reality is a term that provides a general definition of the merge between virtual and physical entities. In 1994 Paul Milgram and Fumio Kishino defined a Mixed Reality as being "...anywhere between the extrema of the Virtuality Continuum (Milgram & Kishino, 1994). Hence, it implies a combination of the two worlds, but where the proportions of virtual respective real are anywhere on the scale between the two (se figure 1).

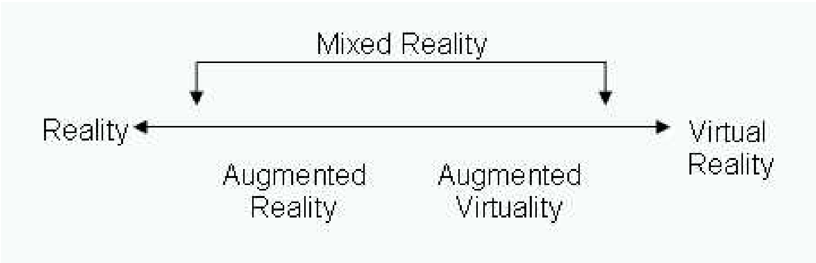

Fig. 1. Paul Milgram's Virtuality Continuum (source: Milgram & Kishino, 1994).

Based on the Virtuality Continuum, games can roughly be divided into three categories, i.e. real world games (e.g. board games and lawn games); virtual reality games (e.g. desk top computer games) and mixed reality games (Hinske et al, 2007). The term mixed reality is sometime used with reference to augmented reality. However, mixed reality is a general term which is not explicitly associated with any specific technology or course of action. In this sense AR is rather a subfield of mixed reality.

Pervasive games

Pervasive gaming is a term that recently has gained a lot of popularity. It originates from the field of pervasive computing which was introduced by IBM in 1998 based on the concept of computing 'anywhere, anytime' (Hinske et al, 2007; Lindley, 2005). In an early vision on pervasive games the following three aspects were central. First, it should be playable on mobile equipment. Second, it should relate to the real life world. Third, it should be possible to play anywhere at anytime (Montola et al, 2006b). Today there exists a number of definitions on pervasive games (Nieuwdorp, 2007) and the term is often seen as a genre, arching over subgenres such as mobile games, augmented reality games, location-based games etc. (Montola et al, 2006b). However, pervasive gaming can also be regarded as a subgenre to mixed reality games. Hinske et al (2007) gives “EyeToy”[1] for Sony Playstation as an example. “EyeToy” is a mixed reality game, since it combines physical and virtual components but it doesn’t make use of any mobile equipment.

One of the first games referred to as pervasive was “Botfighters” from It’s alive, launched on the Swedish market during spring 2001 (mGain D4.2.1, 2004). Botfighters is an action game where the player takes on the role as a robot and battle against other robots i.e. other players, out on the streets. The game is played on a mobile phone via SMS or J2ME client. It utilizes the players’ location and proximity to each other. When playing the game the players locate each other with their mobile phones, move physically to get within range and then duel by “shooting” at each other over the mobile network. An attack from another player can occur anywhere at anytime, as long as the player has his mobile phone active. The game developers’ initial vision was a big and sophisticated multiplayer adventure world, where the player constantly could be pulled in to an ongoing adventure. The inspiration came from the film “the game”, where the main character unknowingly gets enrolled in a game that integrates with his everyday life (mGain D4.2.1, 2004). When designing Botfighters they kept the basic ideas of using the real world as game board where the player always is part of the game, but developed a relatively simple concept that people would recognise. Other early commercial attempts to realize the vision of pervasive games includes e.g. “Majestic” from Electronic Arts and “Nokia game” from Nokia (mGain D4.2.1, 2004).

Academic research has during the last years greatly influenced the area of pervasive gaming, not least through the extensive European commission funded project IPerG - Integrated Project on Pervasive Gaming that started in 2004. Here, a pervasive game is defined as:

> *Pervasive game is a game that has one or more salient features that expand the contractual magic circle of play socially, spatially or temporally. (Montola et al, 2006b)*

Their definition is intended to focuses on the game event and game-play experience, rather than on the technology behind the experience. Pervasive games expand spatially, temporally and socially beyond the boundary which usually surrounds the game experience in ordinary

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[1] http://www.eyetoy.com/index.asp [accessed 15 April 2008].

game play. With reference to Salen and Zimmerman they argue that this boundary is a "magic circle" which acts as a protective frame between the artificial game world and the player's "real life" context (Salen & Zimmerman, 2003). Salen and Zimmerman argue that the magic circle creates a new reality which demarcates the game experience in space and time. It additionally creates a feeling of safety as the player knows that his actions do not impact on real life. However, the borders of the protective frame get blurred when the physical environment and real life domain are mixed. Common research questions within the pervasive gaming research community concern different aspect of the spatial, temporal and social expansion that might occur during the game-play of a pervasive game. For example, spatial expansion is studied by exploiting ambiguities and limitations in available technology (Chalmers et al., 2005; Barkhuus et al, 2005). Furthermore, the blurring of the distinction between players and non-player has been another topic (Montola & Waern, 2006a).

Location-based games

A location-based game is linked to geographical locations and can be experienced through the use of mobile technology. A building, or even a whole city, might constitute setting for a game. The player can then experience it by moving around in the physical environment and by being physically present at specific locations. These games rely on some kind of localization technology. For example, a player's position in the game can be determined by GPS satellite signals, WiFi; GSM signal strength or cell identification. Other positioning technologies include short range proximity-sensing technologies such as RFID, infrared beacons, or ultrasonic emitters (Magerkurth et al, 2005). The linking of game events to locations are done by manual design labour or by linking to digital maps in ways which rules out other game experiences than basic navigation tasks such as chasing other player or finding specific locations.(Gustafsson et al, 2006). The dependency of manual labour to create rich experiences is a critical problem in this area, not least for journey games. Hence, an issue concerns how to scale location-based games to cover vast space and make them available irrespective of where the player is moving. This issue will also be further presented in succeeding chapters of this thesis.

Tangible games

The term "tangible user interface" (TUI) was introduced by Ishii and Ullmer in 1997 (1997). According to them, tangible interfaces give physical form to digital information, which makes it possible to employ physical artifacts both as *representations* and *controls* for computational media.

> *Tangible user interfaces (TUIs) couple physical representations (e.g., spatially manipulable physical objects) with digital representations (e.g., graphics and audio), yielding user interfaces that are computationally mediated but generally not identifiable as "computers" per se. (Ullmer & Ishii, 2000).*

A number of studies have explored the use of tangible user interfaces for game-play (i.e. tangible games) (Ishii et al, 1999; Cheok et al, 2002, 2003; Brunnberg, 2004; Brunnberg & Juhlin, 2006; Magerkurth et al, 2004), ranging from stationary indoors setups (e.g. table top games) to mobile outdoor settings (e.g. location-based games). To play journey games in a moving vehicle means that the player spends very limited time in the vicinity of any single location along the road. Accordingly, to create an experience where the physical road-context and the game come to create a coherent reality, the activity of playing the game and looking out has to be tightly integrated. In this thesis we explore the use of tangible user interfaces to afford an interaction which enables a visual focus of attention on the road-context during game-play.

Chapter 3

The Highway Experience

This chapter will discuss research, which has investigated the characteristics and experience of travelling along a road. More specifically, we will introduce theories by architects such as Donald Appleyard, Kevin Lynch and their colleges.

When a passenger looks out of the windows of a moving vehicle, they perceive a continuous flow of impressions and new situations. The changing scenes; the sense of motion and the contingent encounters, provide for a special sensation, also referred to as the *highway experience* (Appleyard et al, 1964). Nevertheless, roads are often considered as ugly and boring. During the 1960's the architects and urban planners Donald Appleyard and Kevin Lynch, with colleagues, did comprehensive analyses of the experience of road-use (Appleyard et al, 1964). They stressed the potential beauty of highways and argued that the experience of road travel could be more enjoyable if road constructions, of various sorts, were informed by detailed studies of road users' experiences. We will present aspects of their research, which we suggest are of importance for the design of journey games. We are especially concerned with a passenger's experience of individual road objects and the experience of the temporal unfolding of the road-context.

The experience of individual road objects

In the following we will discuss ways in which a passenger experience individual road objects, which passes by outside the window of the vehicle. We will here make a distinction between two different types of road objects encountered during the journey, i.e. roadside objects and other moving vehicles. With roadside objects we mean a somewhat stationary entity or area such as a house, a forest or a power line located beside the road. It might change slightly over time. A house might be repainted and hereby change colour. But it is static in the sense that it doesn't move around. This is not the case with vehicles travelling along the road network. These objects are highly dynamic and mobile. Roads are exploited by various kinds of vehicles and human beings. Busses, trucks, tractors, cars, motorcycles, bicycles and pedestrians are all sharing the road-space. Hence, any road-user's journey often coincides with many other peoples' journeys. Accordingly, it is a space that needs to be negotiated and where humans have to coordinate their actions, i.e. it is a space where a lot of social interaction is taking place (Juhlin, 2001). Traffic encounters arise when two or more people on the roads are co-located and are within visible sight of each other e.g. in intersections, passing in opposite lanes or when overtaking. An encounter can be extremely momentary due to high relative speed whereas others can be more persistent. A meeting in opposite lanes would normally be very momentarily, while vehicles travelling in the same direction might be co-located for an extended period of time. The relation to accompanying traffic might also suddenly change if the vehicle has to stop, such as in case of a traffic jam, at a red light or during an accident or car breakdown.

The passengers' experiences of individual road objects will be further discussed based on a rather rudimentary distinction between their spatial characteristics (Harrison & Dourish, 1996), and how they are perceived and experienced by the passengers. The latter includes both understanding how the practical situation of sitting inside the vehicle influence the experience of objects, as well as their personal motivations and interests.

The spatial appearance of objects

A passenger's experience is obviously influenced by an object's spatial appearance. Appleyard et al (1964) argues that road objects have characteristics in themselves that influence passengers' attention. Many objects might pass without further notice, while others catch the attention and hence shape the passengers experience of the physical surrounding. These objects might be interesting in themselves by displaying fascinating details, dimensions, colours or activities. Or they might arouse the curiosity by being rare or exceptional. Additionally, moving objects, such as trains, airplanes and fellow road-users constitute an important and fascinating component of the highway experience and hence easily draw the attention to them. Furthermore, the perceived experience of road objects is likely to change over time. Accordingly, following one and the same road twice often mean a new sensation. The landscape might be viewed in different lightning, objects might for example be painted in red during sunset or silhouetted against the sun during late afternoon, be invisible during night or throw strange shadows during a specific time of the day. Objects might be covered with snow or be burned and dried by a scorching sun. New object might have been added along the road such as a private sign advertising local strawberries, a wrecked car in the ditch or a run over animal, or have been moved or disappeared from its previous spot (Esbjörnsson & Juhlin, 2002). The road might be calm with no other traffic or busy because of an event in the local community centre.

Tending to visual experiences

The experience of road-objects is to a large extent shaped by the passenger's practical constraints of being inside a vehicle. A passenger apprehends the external road-context primarily through her visual sense, framed by the windows of the vehicle. The closed in position in the car blocks out many other impressions, such as the sounds of the landscape; the smell of roadside scents, or the tactile feeling of the wind. Furthermore, the vehicle is often moving in high speed through the landscape, which makes the passenger only catch brief glimpses of objects and actions on and beside the road (Juhlin & Normark, 2006). While travelling through the landscape the passenger can't talk to people on the roadside or in other ways learn to know the place that is passing by. Accordingly, a travelling passenger misses out on details in the local context. This situation contributes to what we in this thesis refer to as a passenger's cursory experience of road objects.

The passenger adapt to the specifics of experiencing the landscape through the visual sense during very brief moments. In the end, what road objects will influence a passenger's highway experience depend on the ways in which she copes with this practical situation. According to Appleyard et al (1964), this practice is influenced by several factors, such as an objects *distance* from the passenger, the *speed* of her vehicle, and the *shape* of the road she moves through. First, a passenger's focus of attention depends on surrounding objects distance from the road. A passenger is more likely to attend to near objects in the immediate environment than to distant stable ones. Second, the angle of the gaze of the passenger is highly dependant on the speed of the vehicle. A rapid speed generally cause a visual focus of attention directed forward, while a slower speed allows a more general scene where the passenger might pay more attention to objects located on the roadside. Additionally, the shape of the road itself can contribute to the direction of the attention. According to the authors a turning road would for example direct a traveller's attention in an outward angle, as we illustrate in figure 2.

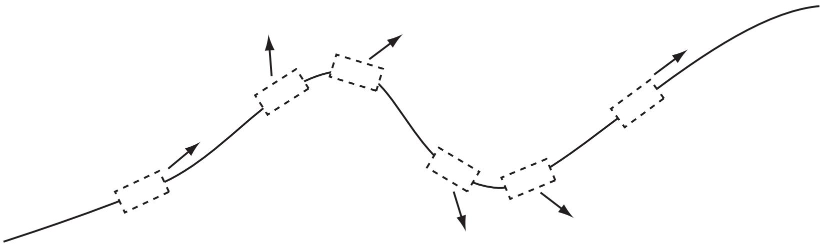

Fig. 2. A curve influences the traveller to turn the visual attention in an outward angle.

A passenger's personal interest

The way in which a passenger chooses to look out onto the road also depends on their personal interests and motivations. A tourist, or a person that travels along the road for the first time, will probably attend to different objects in the surrounding landscape, than if he or she commutes along the road every day or are well acquainted with the area (Appleyard et al, 1964). Furthermore, individual's personal interest shapes which objects' that capture the eye of the beholder. Some might be interested in gardens and houses while others are keeping their eyes open for churches, horses, pretty people or how the farmer is cultivating his land.

The temporal unfolding of the surrounding road-context

A passenger moves both physically and visually within the space surrounding the vehicle. Hence the passenger is presented with a continuous flow of impressions and new situations. Appleyard et al describe the highway experience as a "sequential experience, resembling a dramatic play of space and motion, of light and texture, all on a new scale." They suggest that it resembles a work of art similar to architecture, cinema or dance:

> *The sense of spatial sequence is like that of large-scale architecture: the continuity and insistent temporal flow are akin to music and the cinema. (Appleyard et al, 1964, p. 4)*

The sequential order of impressions is highly dependant on how the passenger progress through the road-network. First, a road can normally be followed in two directions. Travelling along the road in one direction would contribute to different order and visibility of objects and other roadscape features, than if it was followed in the opposite direction. Second, the passenger might enter and leave at different points along a road.

The temporal unfolding has also consequences on a lower scale. The variations of spatial relations in between individual objects, caused by the vehicle's movement, feed into the experience of motion (Appleyard et al, 1964). The passenger gets a sensation of movement when she is looking out of the window and sees the motion of surrounding objects and the shape of the space being moved through. First, a passenger interprets progression within the landscape mainly based on the apparent motion of roadside objects. More specifically speed is by this means interpreted based on the visual perception of the passage of roadside details, and the apparent rotation of near objects around far objects. A landscape with many highly articulated objects close to the road generally contributes to a feeling of greater advancement and velocity than a vast empty space. Objects on the roadside appear to swirl around each other in an "intricate dance" with a rhythm based on their distance from each other and to the viewer.

Second, the shape of the space is likely to change from one moment to the other, which strongly influences the highway experience. It might change from the confinement in a tunnel to spatial freedom on an open field. It might also alter from a congested suburban to the prevailing calm on a small affiliated side street. The traveller might be offered a dramatic experience where objects suddenly appear and rush by along a winding road, or a more stable and soothing experience where objects gently move against a large background or slowly pass in far distance. A uniform and predictable space often contributes to a sense of fatigue and boredom during a journey, while spatial change and contrast in the surrounding landscape often add to a gratifying experience.

Summing up, the passenger's experience of various road objects, i.e. the highway experience, is a critical dimension in the design space we investigate in this thesis. The studies that architects like Kevin Lynch did in the 1960s and 1970s provide an essential framing for this research. The careful and detailed analysis, which reveals both the characteristics of road objects, and how a passenger tends to them, is a useful theoretical starting point. But their influence on this work goes even further, since they also intended to influence design, albeit not of mobile technology but roadside architecture of various forms, as will be discussed in the next chapter.

Chapter 4

Framing the design-space

According to Appleyard et al (1964) the sensations of space and motion, light, colour, and texture from roadside details, or even secondary senses such as sound, smell and touch all constitute materials for the designer to direct and shape the impression and to build dramatic effects. In this chapter we will look closer at how the highway experience could be used to provide drama and challenge to a journey game. We will have to explore new design solutions which bring about usability and playability requirements that to a great extent still constitute unexplored terrain (IPerG, 2004).

We argue that the prospect of using the dynamic and vivid context of road travel to provide drama and challenge to pervasive games especially raises five design issues, namely how to:

- Map game theory to journey experience
- Enable interaction with road objects
- Create experiences based on road objects
- Match game-content to the temporal unfolding of the surrounding road-context
- Account for traffic safety

In the following we will discuss these issues with reference to games research, and theories on the highway experience, presented in the previous chapters.

Mapping game theory to journey experience

We need to look at how the players' view from the windscreen becomes integrated with the game experience. Hence, the main characteristic of the gaming situation presented within this thesis constitutes the relation between "the game/player and the world" (Eskelinen, 2001).

In contrast to traditional computer games where the world generally is presented graphically on a screen, spatial representations is here constructed by physical objects and topographical features in the scenery residing outside the windows of the vehicle. As earlier mentioned (see chapter 2) the game world can potentially be interpreted, explored and manipulated by the player during game play (Eskelinen, 2001). An important issue is to map and balance these aspects of gaming into this particular design space.

Interpretation is here implying the players' understanding and conception of physical objects and places as part of the game. Exploration refers to the players' experience of moving and travelling within the game and especially the ways in which they look for and identify physical objects relevant for the game play. According to Eskelinen a game should also provide manipulative challenges, where the player's actions are of fundamental importance. In this thesis manipulation of game world will not refer to actions which configure or change the actual spatiality of the space itself. This is common in traditional computer games where a player might be able to for example open a door or destroy a city. Instead, in our design we refer to the player's choices and actions in relation to the surrounding physical landscape, which influence the game in some ways. For example, as when a player point the game device towards a grave yard to listen into voices from the past and hereby receive clues about an unsolved murder case.

Importantly, the gaming situation in the journey games has a particular characteristic, which distinguish them from many other games. In a traditional computer game a player can often explore and manipulate the scenery by moving an avatar in a virtual game world. In recent pervasive games, the same form of configuration is achieved when the player per se moves around (e.g. Flintham et al, 2003; Barkhuus et al. 2005). However, when playing a journey game the movement is determined by the driver. The player doesn't have any control over where and how to move around in the game world. The player can't simply skip to enter a specific area or stop at an interesting place to explore it in detail. Instead the player has to perceive the game world in the spur of the moment as it passes by outside the window of the vehicle. Hence, in journey games exploration is an interpretative practise in that the player is feed with a sequential experience, rather than to the maze of possible choices provided by an ordinary navigational game world. We argue that this experience, to an extent, embraces qualities that both resemble dark rides and linear media, such as film. This has led us to make a match between design for exploration and design of narratives.

A primary focus on either context-aware exploration, or context-aware manipulation, influences how the game is designed, as well as how the highway experience is used in the game. A game based on, e.g. narration and the creation of an interesting story based on the passing physical landscape, might for example make use of objects in a different manner and have other demands for interpretation, exploration and manipulation than a game where for example manipulative challenge is the main motive for the experience.

Enable interaction with road objects

By providing a game which is conceived to take place outside the windows of a vehicle, we aim for a concept that depends on the players' possibilities to see the physical surrounding during game-play. In other words, we look for ways to enable interaction where the physical road-context and the game, with its user-interface, come to create a mixed reality. Due to the player's movement in space, the time for interpretation, exploration and manipulation is very limited. Accordingly, the activity of playing the game and looking out has to be tightly integrated. Consequently, a central research question concerns how to enable and balance the player's engagement between computer generated output and the external physical context, while still providing for a meaningful game-play. In this thesis we refer to the notion, where players visually perceive the surrounding landscape and at the same time experience it through digital media, as *blended interaction*.

Traditional screen-centric interaction risks having the player focusing on the computer's screen interface rather than looking out through the windows of the vehicle. Hence, it could spoil the specific benefits of the highway experience. In order to design for interaction when people move quickly around, and when the time for interaction is very short, we would need to explore interfaces that can be handled and experienced without specific visual attention to the game device during very limited time-span. Here we have chosen to investigate the possibility to utilize augmented reality, tangible user interfaces as well as audio-centric interaction. We explore the players' abilities to apprehend multiple sources of information at once and how they make choices about what to attend to and when. According to Trevisan et al (2004) designers can influence what users look at and interact with by controlling attention through the design of the synchronization and integration of the user interface. Synchronisation refers to the ways in which an event controlled by the system is temporally unfolded. The system can present media, demand input or request a task either simultaneously or in a sequence. Integration refers to choices of what types of interaction will occur, e.g. how the user will receive feedback and how the media are distributed to output devices. Furthermore, integration refers to where the media is presented vis-a-vis the user's attention, i.e. in the central or peripheral context of the focus of attention. We further investigate how to influence the player attention towards the physical landscape through the design of game characteristics such as the way the game is explored or how it should be manipulated.

Create experiences based on road objects

In this section we will discuss various ways in which we can design games that merge with road objects. First, we will present different design approaches aimed to handle the cursory experience. Second, we will look at the characteristics of different road objects in relation to game design. Third, we consider how objects can be integrated into the fiction.

Signs, buildings and flags etc. are used to communicate to passing travellers and hence to compensate for a lack of direct contact in traditional highway design (Lynch & Southworth, 1974). The frequent use of automobiles in the middle of the 20th century caused a change in form and content of road-signs. The speed of the vehicle, as well as its enclosed and isolated nature contributed to that the signs grew in size and decreased in textual content. The form and appropriate content of road signs were a frequent discussed topic among urban planners and architects during the 1960's and 1970's (Juhlin & Normark, 2006). The influential urban architects Donald Appleyard, Kevin Lynch and Robert Venturi with colleagues came to develop different approaches as how to design for the cursory experience of the roadside (Juhlin & Normark, 2006). We will in the following tease out three design approaches which are more or less influenced by their theories. They will here be referred to as *transmitting, transforming* and *twisting*.

Transmitting the local context

According to Appleyard et al. the understanding of local context is an important ingredient in the establishment of an enjoyable highway experience: *(t)he sight of activity, or a sense of the meaning and use of areas, is an important pleasure of the road (Appleyard et al, 1964, p. 17).*

Hence, they promote a design approach aimed to, what we will refer to as, *transmitting* the meaning of objects and places from the people living along the road to the people who are just passing. This will make the local context transparent to the passing road users. The highway should in other words be designed to make people aware of the use, history and human values of the surrounding roadside*. The roadside should be a fascinating book to read on the run (Appleyard et al, 1964).* In this way signs along the roads should be used to communicate local matters rather than for example de-contextualised advertisements. They further propose broadcasts of local news, use and history to the passer-by, in order to further enhance the apprehended experience and understanding of the surrounding roadside.

Transforming the experience

Juhlin and Normark (2006) sees another way of designing for the cursory experience of the roadside in the research of Venturi et al (1977), which we will refer to as *transformation*. Instead of bringing forth the local context the passenger's detached experience allow the designer to play around with completely new roles and meanings. A passenger's unawareness of local context could in this way be used to provide fantasy and illusion to a place.

The transformation approach is based on Venturi et al's classic book *Learning from Las Vegas*. It presents an analysis of the famous strip in Las Vegas (Venturi et al, 1977). The authors carefully describe the strip's unique signage used for communication, promotion and persuasion aimed at motorists driving along the road and pay particular attention to the way in which the architecture becomes the advertisement.

Fig. 3. The strip, Las Vegas, Photo: Alex Morrice (Creative Common, Attribution-Noncommercial-Share Alike 2.0 Generic)

Las Vegas constitutes a space where form follows fantasy rather than accommodating the dominant styles in architectural theory or high-art taste. It is a space for dreams, illusions, fantasy and desire. Here the visitor might take the role as a rich gambler or as Elvis Priestly for a couple of days. It grew incrementally through experiment and grand visions and has been described as a mass culture revealing and broadcasting the dreams, fantasies and desires of American mass culture (Hess, 1993; Schieck, 2005). It is described as a space which is dominated by mixed media rather than pure architecture, as a space dominated by signs and symbols rather than by architectural form. It communicates with and persuades visitors through words, pictures and sculptures, even the buildings themselves are signs (see figure 3):

> *If you take the signs away, there is no place. Las Vegas is intensified communication along the highway. (Venturi et al, 1977, pp. 13)*

Venturi et al thoroughly discuss the placement and order of signs and buildings and their size and angles toward people in cars. Venturi's intention was to learn new and vivid lessons about impure architecture and communication from the Las Vegas strip in order to evolve new theories and concepts of form more suited to twentieth-century realities. The book came to be important contribution to post-modern architecture, rejecting the modernist's ideal of "less is more" in favour of symbols, ornamentals and the "ugly and ordinary".

> *The Strip shows the value of symbolism and allusion in architecture of vast space and speed and proves that people, even architects have fun with architecture that reminds them of something else, perhaps of harems or the Wild West in Las Vegas, perhaps of the nation's New England forebears in New Jersey. (Venturi et al, 1977, p.53)*

Based on the Las Vegas study the authors illustrate this style with the term "the decorated shed" representing a way in which architecture can convey meaning. The "decorated shed" consist of a rhetorical front and conventional behind, that is, an architecture consisting of a modest building with applied symbols, e.g. a shelter with an extravagant decoration in front.

Fig. 4. New York-New York Hotel & Casino, the strip, Las Vegas, Photo: http2007 Thierry (Creative Common, Attribution 2.0 Generic)

A traveller's unawareness of local context and weak connection to the roadside could in this way be used to engulf the traveller in a new role and provide fantasy and illusion by heightening the symbolism of surrounding roadside objects e.g. signs and facades in Las Vegas. Hotels and casinos along the strip are represented as e.g. fairy castles, Egyptian pyramids or New York City (see figure 4). Hence, the speed of the vehicles erases the ordinary local meaning of individual geographical objects, which is then transformed into something completely different through the large scale roadside architecture.

Twisting the local context

We have also identified a third design approach, referred to as *twisting* the local context. It resides somewhere in between the two earlier presented approaches, by associating new meaning to an object (transforming), while still retaining and supporting its local meaning (transmitting). This design approach is also influenced by Venturi's theories and especially his visions of post-modern architecture (Venturi et al, 1977). Venturi argued that heightened symbolism and ornaments in architecture can turn the common into the uncommon: *The familiar that is a little off has strange and revealing power (Venturi et al, 1977).* By altering the scale or context of familiar and ordinary objects the familiar gains an unusual meaning, which enables the imaginary of people. Venturi on his part was influenced by pop art. Pop art was a 20th century art movement that made the common uncommon by giving cliché a new meaning in a new context (Venturi et al, 1977). They celebrated everyday objects, such as soup cans, washing powder, comic strips and advertisement. Everyday objects were altered into unusual juxtapositions in order to give them new associations and flout their normal notion of context and meaning. One leading pop artist who has demonstrated the power of the imagination to transform the everyday environment is Claes Oldenburg (National Gallery of art, 1999). Oldenburg is known for his public art installations of everyday objects that are enlarged to gargantuan proportions or which gain a new quality by a change in material. The artist scratches the apparent surface of familiar objects in search of what *he has called "parallel realities"* (National Gallery of art, 1999) or the multiple identities a form can take. An example of his work is “the Needle, Thread, and Knot” located in the busy intersection of Piazzale Cadorna in Milano, Italy (see figure 5).

Fig. 5. Ago, Filo e Nodo (Needle, Thread, and Knot), 2000. ©Claes Oldenburg and Coosje van Bruggen, 2008

Twisting a journey game

In this thesis, when discussing the design of journey games, we will similarly argue for an approach aimed to twist the meaning of the surrounding road context. At the same time as we want to provide a playing passenger with an imaginative fiction, we also want to draw upon the locality of the surrounding road-context. Hence, we make use the everyday meanings of objects, and make the fiction fit with them (figure 6).

With the twisting approach a church would for example be referred to as a church and not a space rocket and a village would be assigned by its proper name and not an invented. By applying fiction to the object a player then might be able to hear sounds of a ritual performed inside the church or find out about a fictional character living in the village as he passes by in the vehicle.

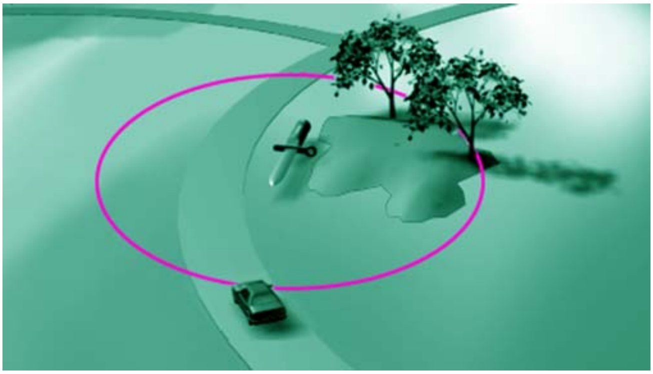

Fig. 6. Providing a twisted experience of the roadside

At the same time as the cursory experience provides us with an opportunity to engulf the player in a new role and provide fantasy by twisting the local context, it also entails a challenge in how to link the fiction to the physical surrounding. We first need to choose which objects in the geographical landscape that will be principal for creating a twisted experience of the surrounding road-context. Then we need to integrate them into the game in such a way that the game becomes an understandable and engaging experience.

Road objects for twisted game design

We will discuss which road objects and places that could be of use when creating a twisted journey experience. The roadside landscape consists of an abundant amount of objects, typological features and geographical places. Due to the cursory experience of the road-context, passengers are only able to catch brief glimpses of objects as they quickly pass by outside the window of the vehicle. Hence, they miss out on a lot of details. Furthermore, different kinds of objects comprise different characteristics that need to be accounted for when designing a pervasive game. Consequently, they convey different prerequisite for interpretation, exploration and manipulation during game-play. We therefore need to make careful choices of which objects to include in the game. Research on the unique characteristics of the highway experience presented earlier can therefore contribute when choosing the most viable objects for different kinds of game events. In this thesis we will look at two different types of objects, which both make up the highway experience, i.e. roadside objects and other moving vehicles encountered along the journey. In the following we will present characteristics of such road objects.

Game related roadside objects

Roadside objects can be characterised by *their visibility from the road*, *the meanings they convey* and *how frequent a type of object is in the surrounding landscape.*

First, objects must be possible to see, recognise and single out from the surroundings, when passing by in a car. Accordingly, we are here concerned with characteristics such as, the possibility to discern them from the background, objects' size and their distance from the road, as well as possible occlusion by other objects. Occlusion could occur during brief moments or persist when passing by in a vehicle. It is important to consider the size and shape of a physical object. An object could be a *single item,* such as a house or a tree. It could also be an *area* such as a forest or a lake, or a *linear* object such as a railway or a power line. A single item is generally passed by, while an area often can be passed through. A linear object can be crossed over or even travelled along. Moving through an area, passing a small object or travelling along a linear object contributes to different sensations and sense of drama. Two area objects of the same type could vary in size. A forest might for example surround the player only for a brief moment, or in other occasions for several hours. Additionally, an area often contains other objects. For example an object referred to as a village might include several houses, a little church and a bus stop. Another characteristic that contributes to the sensation of the journey is an objects' distance from the road. The proximity adds to the sense of motion, which is central to the highway experience (Appleyard et al, 1964). To choose objects close to the road could enhance the sensation of the game-play. The closer the object is located to the road, the time for identification and manipulation decreases, which contribute to a harder challenge and a more intense experience.

Second, we also need to consider the meaning an object conveys. The best objects might not always be located in close proximity to the road. The game would for example benefit if the objects are interesting elements even within the traditional highway experience and in themselves evoke interest. A windmill up on the mountainside; a castle out on a little island or an old ramshackle barn out on a field might immediately attract the attention of the passenger. These kinds of objects easily fire the imagination of the player. They are a great resource for the game and can be used to infuse fantasy and imagination to the game-play even at distance. Some objects might stand out from their surrounding by displaying strange shapes and colours. Other objects might evoke questions concerning their everyday use or display interesting activities. Some objects might evoke strong feelings and others display beautiful scenarios. This means that we should not only choose objects based on their proximity to the road, but also look at the meaning they convey.

Third, some types of objects are more frequent in the landscape then others. A player might for example frequently pass residential buildings and fields, while more seldom passing a castle or a sports ground. Rare respective frequent objects can in much respect be used to balance the requirements between imaginative scenarios and pacing during game-play. Frequency is also relevant depending on the kind of game experience that is inquired. A frequent object type might for example be valuable in a challenge based game and less so in a game that draws on a context-dependant narrative.

Moving vehicles in game design

In addition to roadside objects we also explore the possibility of using other moving vehicles as resource for the game-play. The prospect of designing IT-supported experiences for face to face meetings in traffic has been explored and verified in earlier research but for other areas of use than games (Östergren, 2006). Contingent traffic encounters such as rapid frontal meetings, protracted overtaking or gatherings, such as traffic jams or queues at red lights constitute an important and fascinating component of the highway experience and are likely to catch the attention and curiosity of the traveller. (Appleyard et al, 1964). Face to face meetings with other players during the journey can be utilized to add social and opportunistic play to the game. We will look at how these meetings and the motion of the accompanying traffic can be used as a resource in a journey game and how they can add to the game experience.

It is important to recognize that traffic encounters occur in a variety of ways, this imply that different kinds of encounters call for different challenges when designing the game. Encounters where two vehicles travel in opposite direction generally last for a very short period of time, often not longer than a couple of seconds. Overtaking often mean a more protracted co-location than a meeting but contribute to the disadvantage of having another player behind the back during parts of the encounter. Traffic-light accumulations require the players to stand still for a short period of time in close proximity of each other. Thus, different kinds of traffic encounters bring about different challenges regarding interpretation, exploration and manipulation for the game-play, which will be further explored in this thesis.

Linking fiction to road objects

In order to turn the immediate road-context outside the windows of the vehicle into a believable game arena, it must subsequently also be linked to the game. First, objects and places have to be referenced in the game such that the player understands the intended linkage between object and representation. Second, we apply the fiction such that the player finds the linkage believable and meaningful, i.e. we transform the local context of the object. In this thesis we investigate diverse ways to reference road objects. Here, we draw on Krampen´s semiotic analysis of road signs (Krampen, 1983). We have explored design which draws both on symbolic, iconic and indexical referencing. Icons can be seen as signs which closely resemble the referenced object. A photograph or a road-sign showing an elk are examples of iconic referencing. A symbolic sign bears no natural resemblance of the object, but relies on an agreed understanding of what they shall mean. Most words are symbolic signs. Indexical signs are directly linked to the object by cause-and-effect in space and time, e.g. smoke as an index of 'fire', a thermometer is an index of 'temperature' and a signpost is an index to a physical location or object.

Matching content to the temporal unfolding of the road-context

This section deals with how game-content can be temporally matched and composed to the surrounding road-context as the journey unfolds in real-time. It means e.g. to account for where the players have been before, and where she might be going to be later on. This task is complicated by the fact that a passenger’s progression through the road-network is highly unpredictable. Accordingly, a great challenge when designing journey games concern how to make a consistent experience, including the distribution, order and pacing of localized game-content. In the following we will discuss how the game can be distributed in the physical landscape, as well as how to attain a satisfying order and pace of localized game-events.

Distribution in the physical landscape

This section is concerned with the ways in which game-content can be geographically distributed in the physical landscape. As the game is meant to evolve around the scenario seen outside the windows of the vehicle, we need to look at solutions for how the game-system can be aware of the context surrounding the player while travelling along a road. One option relies on *manual labour* to do *site specific design*. A designer can provide the game-system with data about the geographical world and hereby make the game-content fit with unique objects. The designer could for example travel along the roads and visit every location of interest for the game. She could then mark the coordinates and collect descriptive data etc. This would benefit a system, containing detailed and rich data of the physical world, where the designer have great control over the delivered game and is able to maximise the experience at every specific game location. Another option would be to manually mark an object, location or area on a digital map and assign game events without visiting the place. However, our world consists of a vast amount of roads. Accordingly, manual and site specific design contributes to extensive labour and games that could only benefit people travelling along these pre-designed routes. If these kinds of experiences should be available along the whole road network, irrespective of where the player is travelling, we also need to look at additional ways of associating game content to physical entities in our surrounding.

A more potent way of distributing the game is to make use of widely available digital maps. A digital map includes information about geographical objects such as for example road networks; street signs; buildings and topographic features. By using this data a game could be stitched together in real-time in accordance to the immediate surrounding anywhere along the road network. However, this option also means that we need to find a rather generic solution for how the game is framed and composed, which would consequently give us less control over the actual experience that we want to provide. Another possibility of liberating the game experience from a predefined route would be to make use of face to face meetings with other travelling players as resource for game-play. An encountered player could in this way be regarded as a character within the game. However, this solution inevitably relies on the establishment of a critical mass where the experience is dependant on the number of co-located players (Östergren, 2006). In other words, if there are no surrounding players, there will be no game experience.

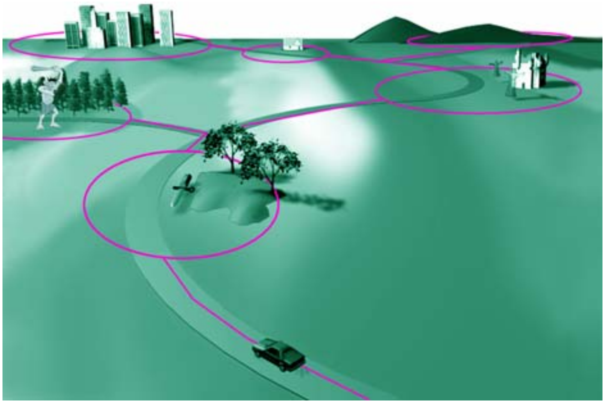

Fig. 7. To scale the game over vast areas

This thesis explores different ways in which to make the game-system aware of the road-context. We will both look at the power and weakness of site specific design and the possibility of using other travelling players in the proximity as resource for game play. We will also explore the option of using digital maps to automatically scale the game over vast areas (see figure 7).

Attaining order and pace of game-events

Once we have made the game-system aware of the physical landscape outside the vehicle, we also need to provide for a meaningful gaming experience that fit with the player's journey. In other words, providing a game experience which is dependent on where the player has been and somewhat also on where the player is going. This raises the challenge of how to provide a satisfying order and pace of localized game-events as the journey unfolds in the physical landscape.

Appleyard et al (1964) describe a journey along a road as a sequence of impression to follow, i.e. a sequential experience of space and motion. They further argue that the shaping of this sequential form is a basic artistic problem. Essential for any sequence is its tempo and rhythm. For a journey along a road this means that interesting impressions and decisions would be presented within an optimal time range. The time between these impressions is essential. If it is to long in-between the impressions, the passenger might be bored. If it is to frequent between impressions, they might be stressed and anxious. The beat of the sequence could be varied, although within the optimal time interval. The beat is also dependant on the velocity of the vehicle, as well as the distance to the source of the impression. Near objects would contribute to a shorter frequency than if they would be visible in the far distance. The designer could choose to create a rhythmic sequence of impressions by emphasising different elements and details in the surrounding landscape. Just like in a movie the designer could choose to vary close-up views with panorama scenes as well as create dramatic effects. The authors further address potential sequential forms applicable for the design of an increased highway experience. One solution would be to design separate sequences for each direction. A sequence might also be built around several self contained episodes, resembling the structure of e.g. a magazine serial:

> *"… thus the sequential form may have to be more like a magazine serial, in which an underlying total development depends on separate episodes, each with a self-contained form of its own …" (Appleyard et al, 1964, p. 18)*

Order and pacing is also important parameters when creating a game. However, to fit the order and pacing of a game with the order and pacing of the highway experience is far from simple. This is especially true if we want to explore alternative ways of creating a game experience which goes beyond a design solution where the player would have to travel along a pre-defined road in a pre-defined manner. The game system would then have to adapt the experience dependent on the travel pattern of the vehicle. To account for every possible path the player might transgress through the road network, poses a problem for design at any specific road section. It follows that there is no logic order in how objects and places appear as the journey unfolds. A house might appear and be followed by a forest, but might also be followed by a field or a lake. To wait for a specific kind of object to appear might take time. It might not even appear at all during the journey. Furthermore, passengers travel through the road network in diverse pace. Different road sections have different speed limits. The car might move very slowly because of traffic congestion, or the driver might stop momentarily at a traffic light or take a momentarily break by the roadside. It follows that it is difficult to create a satisfying order and pacing of the game-events when the designer cannot know in what order or tempo the road network will be transgressed. Hence, we need to look at design solutions where the game is able to dynamically adapt its content in real-time to an arbitrary order of appearing physical objects and places, while still keeping a satisfying pacing of the events.

The order and pace of game events is in many respects dependant on the kind of experience that is desired. A game primarily based on manipulative challenge could for example make use of arbitrary objects, without any specific mutual order or relation to each other. A very simple example of a challenge based game could be to discover churches or mile stones within a certain distance in order to score, or else lose, points. The arbitrary order and pace of events could here add to the challenge of the game. However, when it comes to a narrative based game we argue that the narration should fit with the journey experience rather than to single locations. That is, it should provide a temporally continuing story which fits with dynamically appearing locations in the environment as a car moves through the road network. This put higher demands on the type of object or place that is selected for every event, which accordingly has consequences for the possibility to provide a satisfying order and pacing of the game. In this thesis we will explore the prospect of creating game experiences that fit with the journey based both on narration and manipulative challenge.

Traffic safety

It is essential to account for traffic safety when designing applications for use in a moving vehicle. Regardless, this issue has not been a central research question within this thesis. However, we will still account for our presumptions regarding this issue. During the design process we have aimed for a design which *avoid influencing or distracting the driver* and *keep the players in a safe position*.

First, even though the game is intended for passengers in the backseat who are not engaged in the manoeuvring of the car, we still have to account for safety aspects from the driver's point of view. A driver constantly has to focus on the driving and other activities on the road. Adding extra sources of distraction could have immense consequences. During the design process we therefore regard for game play that avoids distracting the driver or influence the driving per se. Consequently, we consider design solutions which counteract the player's urge to request assistance from the driver to e.g. change travel route, speed or driving style. A change in driving style, such as speeding, sudden breaks and unfocused driving could even constitute a hazard for other road users.

Second, we need to account for the player's safety by providing a possibility to play the game while remain seated in a forward position. The player should feel comfortable with the embodied interaction provided through the game even though they are belted and remain so.

Chapter 5

Design Process

This chapter will address how the previously presented design space has been mapped out and investigated. First, we recognise the larger research programme in which it has been situated. Then we move on to discuss the methods that have been applied.

The work presented in this thesis shares, to some extent, the design space with concurrent research in the "Interactive Road" research programme carried out at the Mobility studio on the Interactive Institute (Juhlin, 2005). The Interactive road agenda explores the benefits of increased interaction for road users by creating innovative services and corresponding technology through interdisciplinary collaboration. It recognises that the highway is, apart from transportation, also a place for social interaction and contextualised experiences. The interactive road research agenda refashion the highway experience by means of novel information technology use. The work presented in this thesis differs from other contributions (Esbjörnsson, 2005; Östergren, 2006; Normark, 2006), since it specifically focus on passengers and games, rather than on drivers.

The interactive road agenda embrace a design-oriented research approach, where knowledge is gained through the process of designing, implementing and evaluating workable prototypes (Esbjörnsson et al, 2004). It is important to notice that the research presented here has not been aimed to find an optimal solution on a well-defined problem. Neither have the prototypes themselves been the end goal. Instead, we investigate the design space through experimental design resulting in several prototypes, which illustrate and highlight different dimensions of the design space. The approach is similar to what Fällman refers to as "design oriented research":

> *In design-oriented research, the knowledge that comes from studying the designed artefact in use or from the*

> *process of bringing the product into being is the contribution, while the resulting artifact is considered more a means than an end. (Fallman, 2003)*

The investigation of the design space has been carried out as an iterative process consisting of four steps (Redström, 2001):

1) Formulating research questions and working hypotheses
2) Design, implementation and performance test of a functional prototype.
3) User trials
4) Analysis and reflection

New knowledge does not only occur as a result of the last step, but is gained also in step 2 and 3 The knowledge gained from the research process give raise to new research questions and feed into the design of continuing prototypes during further explorations of the design space. Hence it is an iterative process where we successively explore the design space.

Formulating research questions and working hypotheses

The generation of research questions and working hypothesis is essential to the investigation of the design space. Our first iteration into the design space (Backseat Gaming) was intended to provide a general understanding of the plausibility of the concept. Furthermore, we wanted to investigate the characteristics of the linkage between roadside objects and a game, in order to create a satisfactory user experience. The second iteration (Road Rager) explored whether face-to-face meetings with other travelling players could be used as resource in game play. This research was highly inspired by already existing research in the group (Östergren, 2006). Our hypothesis was that proximity and a possibility to identify other players during temporary encounters could spur social interaction and enhance a mobile gaming experience. Due to an encounters unpredictable and short nature it also made up a good context to study game-interaction during very limited lifetime. Hence, a central design question concerned the possibility to enable and balance the player's engagement between virtual and real when the time for identification and interaction with the opponent player was very brief.

The third iteration (Backseat Playground) built upon the results from the first study where we had discovered that the children especially appreciated exploration and narrated content that related to road-objects. It led us to the design of the Backseat Playground game, which put a stronger focus on story content and sequential narratives. Furthermore, we had after the first iteration identified the need to explore cost-effective geographically scaleable solutions that would enable widespread gaming and not limit the game-play to specific pre-defined roads. This in its turn brought a need for new solutions regarding how to match and compose game content that fits with the player's journey through the road network.

Design, implementation and testing of functional prototypes

The next step involves the design, implementation and performance testing of a functional prototype which address and challenge the previously formulated research question.

Concept and design

This thesis explores the potential to provide experiences rather than task efficiency (Laaksolahti, 2008). This means that we not only need to provide an advanced technical solution and an intuitive interface, which allow for blended interaction, but also design concepts which provides for interesting and challenging game-play. One solution would be to apply an already existing game, such as the use of the classic arcade game PacMan in projects as Human Pacman (Cheok, 2003) and Pac-Man Must Die (Sanneblad, 2005), or the traditional game Quake in the project ARQuake (Thomas, 2000). However, in our work the design and development of the games themselves have been an important part of the research. The games have exclusively been designed to address the actual research question and to fit the specific context of use. This makes it necessary for us to explore entirely new game designs in a context where usability and playability requirements are entirely unexplored. In this sense, it is part of the exploration of new game concepts in the area of pervasive games:

> *The distributed and collaborative nature of game-play in pervasive games will produce entirely new game designs in which usability and playability requirements remain largely unexplored to date. (iPerG position paper, 2004)*

Accordingly, the research presented in this thesis involves interdisciplinary work where advanced technical knowledge has been combined with creative design and content creation.

Game concepts have been shaped through different means and methods. Situated game design has been a basic feature throughout all iterations. Some part of the game design has always taken place in the intended setting, i.e. by travelling around in the road network. In this way we obtain an apprehension of the context of use, while gaining inspiration and are able to try out possible scenarios. The design process has also included creative workshops and brainstorming sessions. Another method has included the creation of board games where concepts and game mechanics have been tested out in a miniature road setting (see figure 8). Hence, research through play (Zimmerman, 2003) has helped the understanding of possible game-structures in the intended context of use and has provided further inspiration to develop the concept.

Fig. 8. A board game, created during the design of the Road Rager prototype

Implementation

The design concepts are subsequently implemented as a functional prototype. The prototype enables us to explore the design space by trying out hypothesizes and technical solutions in a moving vehicle and through the use of intended users. It also provides a way to communicate the research and concept to the research community and the outside world in a concrete way.

The central hardware used when building the prototypes includes Personal Digital Assistants (PDAs), GPS and digital compass. PDAs have been used as the main platform for the actual game device. They provide open software interfaces, which allow application oriented prototyping (Östergren, 2006). They are also powerful in terms of processing and memory. Furthermore, they are open for integration with various forms of peripheral devices. GPS has been used for positioning of the player and digital compass for sensing the aiming direction of the device. In one of the prototypes a gyro has also been used instead of the compass.

Performance tests

The development process includes frequent performance tests. They inform the design process about flaws and limitations in the implementation. Performance tests feed back knowledge into the development process and hence, might contribute to changes both in technology and design. Tests are conducted in the intended setting, i.e. on the roads, as well as through simulation in a laboratory setting. Figure 9 shows a screenshot from a computer-generated simulation of how a vehicle is moving along a road. This simulation tool was developed by Anton Gustafsson during the development of Backseat Playground in order to test real-time mapping of game content to dynamically appearing roadside objects.

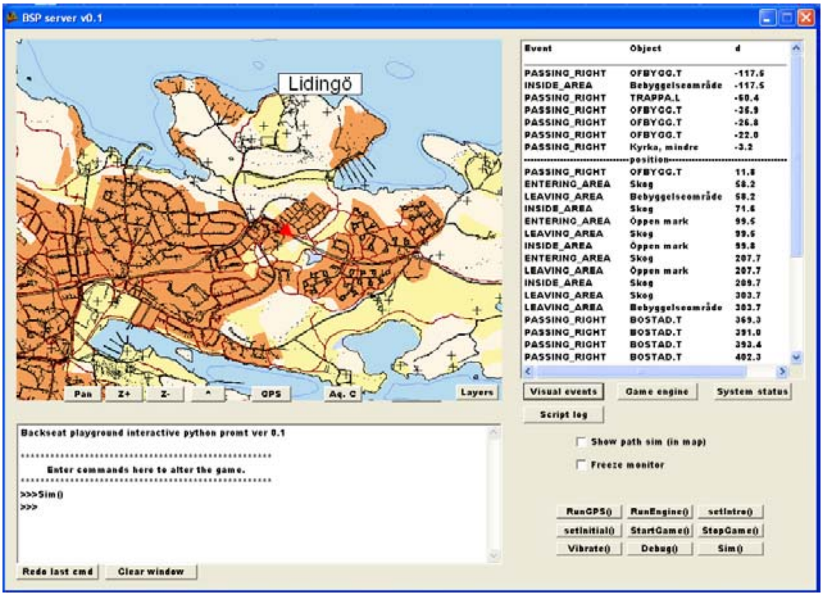

Fig. 9. Simulator for the Backseat Playground prototype (developed by Anton Gustafsson)

User trials

User trials take place when the prototype is somewhat implemented. The purpose is to learn about the usage in a real-life situation. Hence, we seek to perform trials in settings, and with users, that are as close to our intended usage situations as possible (Esbjörnsson et al, 2003). However, the trials have been restricted to preset routes where the subjects used the prototype during a limited period of time. The reason for pre-defining the routes differs in between the three prototypes. In Backseat Gaming this was the only possible choice since the game itself was pre-designed along a specific route. In Road Rager we needed to delimit the road network to ensured encounters in between a restricted number of players. The Backseat Playground trial was restricted since we wanted to stabilise one parameter during the study. Researchers have been present at the trials mostly to capture data, as well as a means for support, which includes driving the vehicle and to provide technical supervision and maintenance (see figure 10).

Fig. 10. Researchers during a user trial of the Backseat Playground prototype (photo: ©Kajsa Olsson)

As our research explores the potential to design experiences rather than task efficiency, it is not appropriate to study the concepts with regard to the time it takes for a specific playing task (Laaksolahti, 2008). Instead, we are interested in aspects such as the players' experience of use, immersion and fun. Furthermore we are interested in how the player interacts with the game and the surrounding physical context during the game-play.

During all trials the players' activities have been video recorded, and loosely structured interviews been carried out after the game-play. A complementary method used during one trial (see chapter 13) is somewhat similar to the "Mission from Mars"-method (Dindler et al, 2005). Here the interviewer shared the narrative space by taking on the role of a fictional in-game character. More specifically, the users played the role of secret agents with the mission to solve a crime mystery. The researcher played the role as a reporter from a local news paper. The method enabled us to get feedback in a play-like atmosphere, where we aimed to diminish the normal roles of researcher and user. Instead we established a common ground where the nosey reporter encouraged the player to give a detailed account of in-game events. In this way we were able to investigate whether they had understood the concept of the game and how they linked the narrative to roadside objects. After one of the trials we also made use of questionnaires for the user to fill in. Further information concerning the game-play was collected by the means of log data provided by the game engine, such as when and where game-events where taking place or how the player proceeded in the game.

The limited time and the staged setting prevented us from studying extended use of the concept. Games are usually designed to promote different strategies and to enable improved gaming skills during extended game-play. This is hard to test during such short period of time. Additionally, the impact of the present researcher might influence the result (Östergren, 2006). Furthermore, flaws occasionally emerged during the trials because of problems with the technology. Regardless, these trials provide valuable insights about the players' perceived experience, interaction techniques and relation to the surrounding physical landscape. Accordingly, we gain knowledge that inform future design and increase our knowledge about the design space and how a pervasive game can benefit from the highway experience.

Analysis and reflection

The forth activity involves a process of analysing and reflecting on the conducted work. This activity has been ongoing during the whole research process. Reflections, insights and design implications gained during the research process is reported and communicated to the research community in the form of posters, workshop papers, journal articles and conference papers.

A period of reflection has especially followed the user trials of the prototypes. Interviews and questionnaires have then been analysed and the video recordings transcribed and coded. From the video recordings we have particularly studied facial expressions, general appearance, visual focus of attention, handling of device and spontaneous comments during the game session. During an early stage of our research this activity relied to a big extent on the work of transcribing and analysing video data (see chapter 9 and 11). However with time, as the research and our understanding of the design space has matured, the analysis has come to rely also on the questionnaires, interviews and logging data. This is partly due to the fact that transcribing and analysing extensive video data is extremely time-consuming. It is also due to the fact that we wished for insights that were difficult to obtain from video analysis alone, such as game progression, geographical location of game-related objects and players' subjective comments on certain aspects of game-play.

Finally, the study of experience of use is not a straightforward procedure as it involves a state of mind subjective to the player, which arises as he or she engages with the game (Zimmerman, 2003). According to Zimmerman a game-designer can not directly create the experience, only the structure and contexts in which play takes place.

> *To design a game is to construct a set of rules. But the point of game design is not to have players experience rules – it is to have players experience play. Game design is therefore a second-order design problem, in which designer craft play, but only indirect. Play arises out of rules as they are inhabited and enacted by players, crating emergent patterns of behavior, sensation and interaction. (Zimmerman, 2003)*

Hence, we do not strive to generalize the observed result from the user trials, but rather to gain insights through individual gaming situations.

Chapter 6

Experimental prototypes

The research presented in this thesis is based on the design and implementation of three experimental prototypes, namely *Backseat Gaming, Road Rager* and *Backseat Playground.* Each prototype contributes in various ways to an increased understanding of the design space by exploring the earlier presented parameters (see chapter 4). This chapter will give a brief description of each prototype.

Backseat Gaming

Backseat Gaming was the first attempt to investigate this novel design space to get an indication of how a journey game could benefit from the highway experience. It makes use of roadside objects as resource for the game and is manually designed along a pre-defined route.

Fig. 11. a) The Backseat Gaming device b) children playing Backseat Gaming

The game is implemented on a Pocket PC equipped with a GPS receiver and a digital compass module (figure 11a). The combination of a GPS and a digital compass enables the game device to recognize both its geographical position and its current bearing in relation to the surrounding physical landscape. The game can hereby recognise if the player points the device toward at certain physical objects as they pass by outside the window of the vehicle (see figure 11b).

The game is about a scientist, who succeeds in inventing a special kind of energy, but gets locked out of his lab and finds himself in a parallel world inhabited by other life forms. The player's mission is to find the scientist and provide him with a key to get back to the "real" world. The player can also reach the parallel world through the game-device which is sensitive to its special energy.

The game is structured into a framing story and location dependant game events. The framing story is told when the game starts to provide the player with an understanding of the goals of the game. A game event is triggered at a geographical coordinate, which coincide with the position of an object or place that has relevance for the game-play. The geographical coordinates of physical game locations are pre-defined in a database together with data that describe the associated event. When the player approaches the location of a game event it will first trigger a local story, which link a sub-plot to the intended physical object and give the player clues about how to overcome the approaching challenge. The local story is presented by means of pictures of the particular roadside object, overlaid with animations and a narrator voice (see figure 12a). A manipulative challenge is triggered when the player comes even closer to the location. The screen of the Pocket PC is then turned into radar mode (see figure 12b), which makes it capable of visualizing virtual objects feigned to exist in the physical surrounding. By aiming the game device towards the physical object as it passes by outside the window of the vehicle, players can either defend themselves against attacking creatures or pick up magic artefacts at the location.

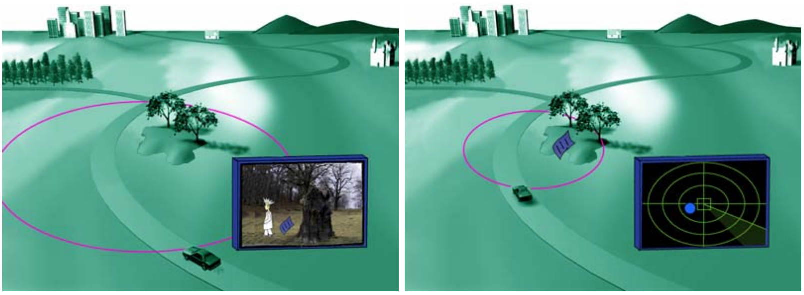

Fig. 12. a). Local story b) Manipulative event

The possibility of manually designing game content which fits with a pre-defined route also means that physical objects and places relevant for the game-play are handpick by the designer. It also gives us an opportunity to explore how different kinds of physical object and places are perceived during game play. Backseat Gaming have therefore been used to study on how different physical objects and places can be used to add drama and challenge to a game and how an object's characteristics influence interpretation, exploration and manipulation during game play. We have been concerned with objects' size; the possibility to discern them from the background; their distance from the road, and the meanings they convey. The chosen objects have either been single items, such as a tree or a house, or an area e.g. an allotment or a gas works. We introduce terms such as *patch events* and *wrap events*. A patch event refers to large physical objects containing multiple virtual objects, which can here be seen as a number of patches on a large roadside body. One example includes an allotment area inhabited by several virtual creatures. Wrap events consist of a singular virtual object tied to a specific physical object, e.g. a virtual document dropped at an old oak tree, or a ghost inhabiting a cottage. This will be further discussed in chapter 9.

Road Rager

The purpose of the Road Rager prototype is twofold. First, we explore the use of other road users as resource for game-play. We suggest that the temporal and unpredictable nature of a traffic encounter, as well as the proximity and the chance to momentarily meet face to face, can provide for meaningful game-play. Second, we investigate how to afford game interaction when the lifetime of a game event is very limited. We specifically look at how the interaction could be supported through the specific design of the user interface as well as the choice of game characteristics such as tasks and the rewards for fulfilling them.

The Road Rager prototype is designed to be a multiplayer game, enabling passengers in different cars to play against each other during a face to face meeting in traffic. It is important to recognize that traffic encounters occur in a variety of ways. We have focused on three different encounters, i.e. meeting in opposite lanes, overtaking and traffic-light accumulations (see chapter 10). These encounters were chosen because they generally constitute short events but bring about different challenges regarding interpretation, exploration and manipulation during game-play.

The game is developed on a PDA equipped with W-LAN capability. Gaming activity is accomplished through peer-to-peer wireless ad hoc networking, allowing connection between the devices without any further infrastructure. Similar to the Backseat Gaming prototype, the device is aware of its direction and tilt by means of a digital compass, and its geographical position by means of a GPS-receiver (figure 13b).

When the game begins the player takes on the role of a character with magic powers. The player's goal is to acquire as much magic power as possible before the yearly witchcraft convention. The devices automatically connect and a game-event is initiated when two players are around 100 meters away of each other (see figure 13a). During the game event the player gain or lose magic power by duelling against contesting players.

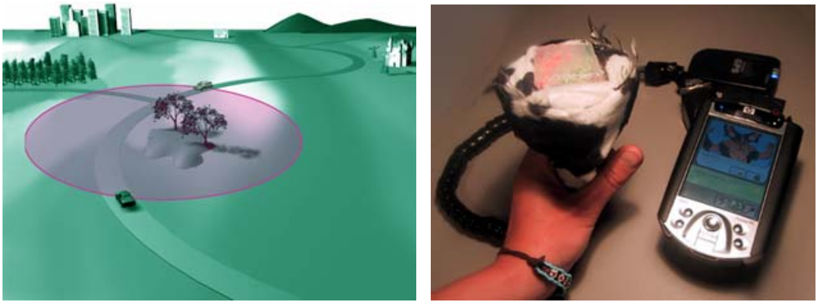

Fig. 13. a) A multiplayer game event b) the Road Rager prototype

The concept depends on the players' possibilities to look out the windows of the vehicle, and spot the opponents, in conjunction with playing the game. As the time for interaction with other players generally is very limited, these activities have to be tightly integrated. Therefore, we have chosen to provide the player with a tangible interface (Ishii & Ullmer, 1997), which would enable her to handle the game interaction while watching out for cars in the vicinity. The interface is realised as a magic gadget, equipped with fourteen LEDs, informing the player of the direction towards the opponent and the amount of magic power the player possesses. To further support a possibility to visually focus on encountered vehicles we use sounds as feedback and guidance for the interaction.

The tangible interface can be transformed into three different tools, i.e. the *Magic Wand*, the *Sludge Thrower* and the *Electro Squeezer* (figure 14). These are intended to be more or less suitable for the different traffic encounters mentioned above. The tools combine user interfaces, tasks and rewards in various ways. The player can use the tools by moving the tangible interface in accordance to certain gestures. The force of a tool is in varying degree dependant on its direction and position relative the opponent player while being used.

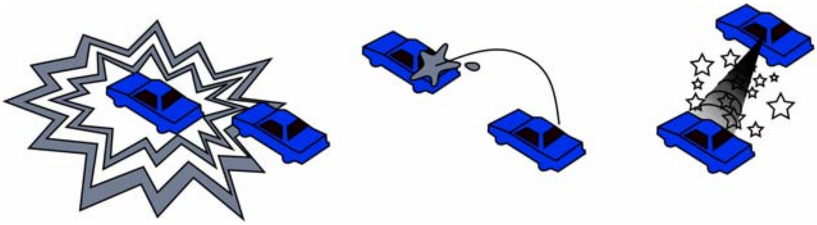

Fig. 14. Road Rager tools: a) Electro Squeezer b) Sludge thrower c) Magic wand

Backseat Playground

Backseat Playground is designed to explore two prospects, which emerged out of the study of the Backseat Gaming prototype. First, we investigate the prospect of automatic geographical scalability by using increasingly available digital maps (see figure 15). Digital maps include layers of physical objects such as road networks, street signs, buildings and topographic features, which can be used to link the game with the surrounding environment by associating roadside objects and places along the roads.

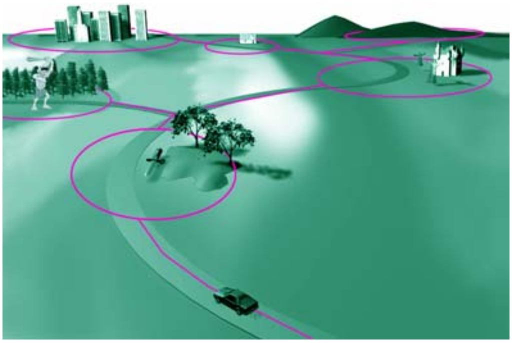

Fig. 15. Automatic geographical scalability

Second, we conceived a game with a stronger focus on story content and explorative aspects in the game-play. Backseat Playground provides a narrative which fits with the dynamically appearing locations in the environment. By using digital maps it continuously reference adjacent objects, such as houses, forests and churches, within the story. Thus, the narrative engine utilizes the movement of the vehicle, and the path of the journey, to dynamically form a temporally continuing story, rather than a random anthology, wherever the player travels in the road-network.

The story, written by the game designer and artist John Paul Bichard, is a crime mystery with a supernatural twist. The player is positioned as a field agent manager in a crime unit, charged with the task of overseeing operations to investigate a series of seemingly related crimes and ultimately to uncover the workings of an organised crime gang. Initially, the player has a good relationship to partner Helena at the head quarter. They build a relationship of trust and cooperation. Whilst the player communicates with agents, the relationship with Helena and boss Ulf alter. By affecting the moods and relationships between player and in-game characters the player's actions unfold a dark adventure.

The platform consists of a game device, a Bluetooth GPS receiver and a server running on a lap top which connects to the game device over W-LAN. The game device is composed by a pocket PC and a gyro, encapsulated by a casing of a directional microphone (see figure 16a). The pocket PC provides both a visual interface through its display, as well as aural interface thought connected headphones. The server and GPS are installed at a suitable place in the vehicle.

Fig. 16. Backseat Playground: a) game device b) players

The game is based on audio centric interaction in order to support a visual focus on the surroundings. The interaction builds upon the idea of having a set of virtual devices i.e. a mobile cell phone, a walkie-talkie and a directional microphone, to explore, reveal and unfold the adventure embedded in the surrounding physical landscape. The mobile telephone and walkie-talkie allow the player to keep in contact with the in-game characters. The game-engine uses text-to-speech synthesizing together with a sound effect system to create life like incoming phone calls and walkie-talkie calls from the in-game characters. During the calls the in-game characters reference geographical objects in the vicinity to link the experience to the surrounding context. The graphical content is minimal. Only a graphic of a notepad, mobile phone or a walkie-talkie is displayed on the pocket pc when the corresponding device is active. Additionally, an options menu is occasionally displayed after a call, in order to let the player select between different action. Furthermore, the interaction builds upon the concept of a directional microphone to investigate the soundscape surrounding the vehicle. By pointing the game device towards objects as they pass by, the player can hear sounds and hereby investigate what is happening in the game (see figure 16b). It mostly plays sound effects, although it is sometimes used together with text-to-speech to let the player listen into conversations. The direction to the sound is based on data from the gyro sensor together with the GPS location.

The server runs a map processing which converts the 2-dimensional digital map data into a linear series of geographical events. These steps include prediction of player's paths; extraction of visually available information and production of journey events through mapping of information onto the predicted paths. The journey event objects are then used as input to the game-engine. The latter rank geographical objects in terms of their interest for the game, and selects which scripts to run, also dependent on pacing requirements. The geographical objects then occur as places with associated sounds which are triggered with the directional microphone, or as local references in the synthetic conversations of the field agents.

Chapter 7

Design insights

In this chapter we present insights acquired through investigating the design space for journey games, and especially the set of issues presented in chapter 5. We will in the following discuss how these issues how been mapped into the three implemented game prototypes, as well as discuss how these implementations were employed and experienced in user trials.

Mapping game theory to journey games

Based on the theory of Eskelinen we have identified a set of general characteristics that provides for game experiences on the road. Eskelinen makes a distinction between exploration and manipulation of the game-world. In journey games exploration is somewhat "passive" and we argue that this experience resembles that of reading a story or watching a film. There of our match between design for exploration and design of narratives. Furthermore, he describes the need of interpretation in games, *"In games we have to interpret in order to be able to configure …" (Eskelinen, 2001),* which in our design space constitutes a basic usability issue. An important issue is to map and balance these aspects of gaming into this particular design space. A primary focus on either context-aware exploration, or context-aware manipulation, influences how the game is designed. The three prototypes explore spatial relations and their prospect to provide an experience by putting different emphasis on interpretation, exploration and manipulation in the games (see figure 17).

The Backseat gaming prototype, put equal emphasis on interpretation, exploration and manipulation. The local stories provide narrative elements which afford an explorative experience. The basic element of interpretation is implemented in the way the prototype support the search for objects along the road. Finally, the prototype provides manipulative challenges. Road Rager provide for identification of objects, as part of providing for challenging game play. The Backseat Playground prototype expands on the narrative aspects of backseat gaming, as well as down-play the role of manipulative challenges.

	Interpretation	Exploration	Manipulation
BSG			
RR			
BSP			

Fig. 17. Spatial relations in the three game prototypes

Game play experiences

Based on analyses of the material collected during the user trials we conclude that the dynamic and vivid context of road travel provide both for narrative experiences as well as for interesting manipulative challenge. In general, the players succeeded with interpretation, exploration and manipulation well enough for us to conclude that journey games are plausible and interesting. More specifically, we conclude that explorative experiences, which thus combine narrative content, and the physical game space, were highly praised. Even in a very simple game, such as Road Rager, the experience of seeing the contestant made the game-play exciting. The players enjoyed identifying who they were playing against, even though it wasn't necessary for scoring. The user trial of Backseat Gaming, also pointed to the potential of providing narrative or explorative experiences in this context, which was then further elaborated in Backseat playground

The studies further suggest that the backseat of the car is suitable for collaborative gaming. For practical purposes, we always had two children in the backseat during field trials. Although not intended, it was usual that both of them were involved in the game-play. It was also usual that the children divided tasks in between each other; one might for example be in charge of the game manipulation and the other of exploring the physical game-world.

Enable interaction with road objects

A basic feature of a journey game is to design for interaction which allows the player to visually investigate the surrounding landscape, at the same time as playing the game. Due to the player's movement in space, the time for interpretation, exploration and manipulation is very limited. We refer to interaction, where players visually perceive the surrounding landscape and at the same time experience it through digital media, as blended interaction. We have investigated the prospect of blended interaction through the use of augmented reality, tangible user interfaces and audio centric interaction.

The prototypes are alike in that the player can interact with the game by aiming the device towards objects in the surrounding physical landscape. However, they differ in how they enable additional interaction with the system and how they present game content and feedback to the player (see figure 18).

	Input	Output
BSG	Direction of the device and button press	Screen based: pictures, animations and graphics with narrated voice and sound effects
RR	Direction of the device and gestures	Customized interface: lights, sound effects, minor graphics on screen
BSP	Direction of the device and button press	Audio centric: text-to-speech and sound effects, minor graphics on screen

Fig. 18. Different means to enable blended interaction

Backseat Gaming uses the screen of a PDA as interface to the digital content (see figure 19a). The screen represents a small and virtual window to a parallel world. Blended interaction is achieved when the player alters her visual focus between the screen and the outside world, while aiming the device at objects in the physical landscape. Then it is possible to attack or suck up virtual objects by pressing a button on the device.

Fig. 19. The physical shape of the three prototypes: a) Backseat Gaming b) Road Rager c) Backseat Playground

Road Rager supports searching and identification through holding the tangible interface in the line of sight and directing it towards objects on the road (see figure 19b). The player can shift visual focus between the informing lights and the traffic. It additionally provides for more abstract form of interaction. The player makes a set of gestures and receives feedback mainly in the form of light and sounds. The user trial of the Road Rager shows that the players struggled with managing the interaction during traffic encounters. It was evident that it is difficult to provide for extensive game-play when the lifetime of a game-event is so short. Even though we intended to provide for very simple and meagre interaction, it turned out to be too much. Thus, minimalism is an essential design parameter for blended interaction. The features and tasks of the game have to be cut down to the minimum. Of course, games should not be designed with that in mind, but also to provide interesting challenges. However, within this design-space, the challenge of the use context itself is so difficult that the designer as a first priority should focus on making the concepts achievable. Abstract gestures such as making magic spells proved to be too complicated. Instead, indexical gestures (Krampen, 1983), such as throwing, made the interaction more intuitive. It was obvious that a very simple interaction still became fun when it was combined with the physical world outside the vehicle.

Backseat Playground on the other hand provides a more audio-centric interface (see figure 19c). The player points the device towards objects in the physical surrounding to listen into conversations or to hear other ambient sounds. Audio centric interaction enables players to concentrate their visual focus off attention on the outside road-context. However, an options menu is occasionally displayed on a screen, whereby the player can select between different actions by pressing buttons on the device. In both Road Rager and Backseat Playground, the graphical information presented on the screen is minimal. However, the user trials showed that even very minimal visual feedback, such as a static image or light, easily drew the player's attention to the physical interface. Therefore, we decided to provide an audio-centric interface in the Backseat playground prototype, which proved to be successful. It created a blended experience, as it both supported the player in looking at the roadside and evoked her imagination.

Insight on players' interaction strategies

We observed a variety of ways in which children interacted with both Backseat Gaming and Road Rager in the trials. We both found ways where they mixed their visual focus of attention between external road-context and the game interface, as well as forms where the players solely focused their visual attention on the physical interface. It might be that the task of combining game play with a blended interaction was to complex and demanding for some players. The study of Backseat playground prototype revealed additional interaction strategies. We termed these techniques: *synchronized orientation; aural orientation; visual orientation and skewed orientation*. Since we designed the interface on a directional microphone metaphor, we initially expected something like synchronized orientation, i.e. that hand and eye movement would be aligned while interacting with the physical surrounding. For most players this was initially true during parts of the trial. But as the players got more familiar with the game play, the interaction technique changed. The most obvious change was the disconnection between hand and eye movements. From this new behaviour two notable interaction techniques emerged. First, aural orientation occurred when the player searched the landscape by initially moving the device to find an interesting sound and then moved the gaze to watch the object. Second, visual orientation took place when the player initially watched for an object and then pointed towards it with the device. A fourth technique, referred to as skewed orientation, were also observed, which combined of the two earlier techniques used in an unsynchronized manner. Hence, pointing and looking were actively conducted in parallel. However, in all these examples we observed how the players manage to maintain a blended interaction by in various ways aligning their visual sight with the direction of the device as soon as an interesting sound or object was discovered. We suggest that the unexpected techniques can be explained as ways to handle the cursory experience. By splitting the visual focus and the hand movement they managed to cover more ground in the search for game events. However, blended interaction was still attained as soon as either an object or a sound caught the player's attention.

We also identified how variations in the speed of the vehicle influenced the choice of orientation methods. We initially expected a greater interest in spatial details and hence, a prolonged orientation towards individual objects such, as displayed in what we refer to as simultaneous orientation. This behaviour also occurred rather frequently as soon as the car slowed down. Accordingly, the players adapted their visual focus of attention very much in accordance with the speed of the car.

Create experiences based on road objects

Our implementation has also focussed on how to fit the cursory experience with fictitious content. We have previously argued for a design approach aimed to twist the local meaning of the surrounding road context. It implies providing a playing passenger with an imaginative fiction, on top of the local meaning of road objects. The cursory experience provides the designer with an opportunity to engulf the player in a new role and provide fantasy and illusion to the surrounding road context. However, this also entails a challenge in how to link the fiction to road objects. Our investigation is concerned with which objects to choose and how to represent them as part of a fiction in such way, that the game provides an understandable and engaging experience.

Objects supporting a twisted experience

Different objects convey different possibilities for adding drama and challenge to the journey. Moreover, objects unique characteristics influence interpretation, exploration and manipulation during game play. In this thesis we have explored two different types of objects, which both make up the highway experience, i.e. roadside objects and other moving vehicles encountered along a journey. The three prototypes differ in how they have explored the use and characteristics of objects (see figure 20).

	Objects	Explored characteristics
BSG	Explicit roadside objects	Size, distance from the road, the possibility to discern from the background, meaning.
RR	Vehicles / other players	Different kinds of contingent traffic encounters
BSP	Generic roadside objects	Size, occlusion, frequency, meaning.

Fig. 20. Road objects and their explored characteristics in the three prototypes

Backseat Gaming makes use of a number of explicitly selected roadside objects as resource in the game. It allows us to discuss the significance of characteristics such as the size, distance from the road, the possibility to discern them from the background and the meaning they convey. The Road Rager explores the use of other vehicles, or more specifically, the use or face-to-face meetings with other travelling players. It specifically addresses how different kind of contingent traffic encounters call for different challenges when designing the game. Backseat Playground makes use of generic types of roadside objects, as available in digital maps, and explores the significance of characteristics such as occlusion, size, frequency, and the meaning they convey.

The user trial of the Backseat Gaming prototype indicates that manipulation was more fun at objects that provided a strong sense of motion e.g. a tree situated close to the road in a curve. The players enjoyed exploration at roadside objects that in themselves evoked interest, such as places that display activity or drama. Furthermore, certain area-objects where the car passed right through the game-space, e.g. an allotment, caught the players' attention. These results from the user trials fit with previous research on the highway experience (Appleyard et al, 1964).

The interviews from the user trial with the Backseat Playground prototype reveal that the players mostly referred to large sized objects, such as lakes or forest. They seldom mentioned smaller objects such as buildings. This could be due to various reasons such as technical deficiencies; occlusion; the way the sounds were designed, or the players' ability to remember different types of objects. It could also be the case that they saw the intended objects, but that the swift movement made small objects visible for such short duration, that it became hard to remember them. Large scale objects, on the other hand, provide more time for identification and interaction. Accordingly, there was just too little time to engage in extensive identification. It follows that the roadside objects must be rather large or highly distinctive. Interestingly, the interviews also reveals that the players in some occasions remembered seeing objects that was referenced in the game, which most likely never were visually identified. This indicates that it is possible to also *transform* the link between their vague understanding of the geographical structure forms and the meaning given to it. In other words, the cursory experience enables the game designer to make the players believe they have seen things which they haven't.

Referencing the road-context

Furthermore, objects must also be linked to the fiction. The prototypes investigate different ways in which to reference the selected road-objects in a way that both transmit the local meaning of them and which transform them in an interesting way (see figure 21). As earlier described (see chapter 4), we draw on Krampen´s semiotic analysis of road signs

(Krampen, 1983). Accordingly, we explore the use of symbolic, iconic and indexical referencing to objects in the surrounding road-context.

	Fact: means to make the player understand what we are referring to.	**Fiction**: means to apply the fiction, creating a twisted appearance of the road-context that is believable and meaningful.
BSG	Iconic: photos Symbolic: verbal association by narrated voice	Narrated voice, graphics, animations and sounds
RR	Indexical: proximity sound and directional light	Sounds and minor graphics
BSP	Symbolic: verbal association by in-game characters Indexical: 3D sound	Verbal dialogs with in-game characters, sounds and minor graphics

Fig. 21. Referencing to physical objects in the three prototypes

First, the prototypes support the transmission of local meaning in different ways. We have explored design which provides symbolic referencing, with verbal associations by in-game characters; iconic referencing such as the use of photographs and indexical referencing with the use of directional light and sound. The Backseat gaming prototype provides photographs of objects. It also uses accompanying narration to symbolically reference objects e.g. *"You will soon come to the small red cabin …"* Road Rager provide an indexical sound effect to inform if another player is in the vicinity and make use of directional light to point out the bearing towards the opponent. The Backseat Playground makes use of symbolic referencing, through the use of verbal association in dialogs with in-game characters, as well as indexical referencing through situated 3D-sounds.

In general, the children understood the fictitious linkage rather quickly i.e. they made a connection between the game-content and the physical surrounding outside the car. Their understanding that the game included the road setting was visible in the ways in which they looked for objects outside as soon as they were referred to in the game.

Second, we have to reference the object in a way that transforms them in an interesting way. Backseat Gaming makes use of narrated voice, graphics, animations and sounds. Road Rager mainly makes use of sounds and to a minor extent of graphics. Backseat playground uses verbal dialogs of in-game characters, sounds and a few graphical images.

The user trials indicated that we managed to create an immersive and believable experience by twisting the local meaning of objects. The players' often perceived the virtual game space and the physical road-context as an integrated whole. This was visible partly in how the players referred to physical objects and handle the gaming-device during the game-play. Some player's would for example avoid aiming the device towards the supposed object if any other physical object, e.g. the car seats in front, were in the way. This indicates that they thought of the virtual content as really being part of the roadside. This was also confirmed by the questionnaire relating to the user trial of the Backseat Playground prototype. All, except from one, players answered that they really felt as if the game was going on outside the window and many afterwards had problems distinguishing what they saw for real and what was perceived through the game device. The children had experienced submarines in conjunction with, what was recognized as water both by them and the map data, as well as wolves in what both they and the story engine recognized as forests. Thus, the system recognized objects everyday meaning but twisted it a bit to provide some fantasy.

Matching content to the temporal unfolding of the road-context

The prototypes implement various ways of matching game content to the temporal unfolding of the journey. First, the game has to be available along a route, and not only at one physical location, since the player moves quickly from one instance to the next. Hence, we need to look at how the game can scale geographically. Second, the game content has to be composed such that it creates a coherent experience. Thus, we need to look at how to provide a satisfying order and pace of game-events.

	Distribution	Composition
BSG	Site-specific, manually designed routes: pre-selected objects	Static and explicit design solution
RR	Automatically scalable over vast areas based on other players: Ad-hoc peer discovery	Adaptable, generic and repetitive design solution
BSP	Automatically scalable over vast areas: Digital maps	Adaptable, generic and evolving design solution

Fig. 22. Different approaches to match and compose game content

Geographical scalability

The prototypes differ in the ways that the games are distributed in space (see figure 22). Backseat Gaming is manually distributed along a specific route, while Backseat Playground is automatically scaled to vast areas by the use of digital maps. Road Rager relies on face-to-face meetings and its availability is dependent on the amount of players in the vicinity.

Based on the user trials we conclude that all three approaches can be used to provide a meaningful gaming experience as the player travels along a road. However, the Backseat Gaming only benefit people travelling along the specific pre-designed route and a scaled version would inevitably contribute to extensive labour for the designer. With the use of digital maps Backseat Playground scale over an area of around 35 square kilometres, which per se is much larger than other similar narrative environments. Since the digital maps used are available for the whole of Sweden it further ensures scalability beyond our test area. The amount and variety of objects in the used digital maps proved to be enough to ensure a provision of a narrative. However, it is important to consider that our test area consisted of both rural and urban areas. Although the game is implemented for a large geographical area, it still needs to be understood whether this applies to other geographical areas. Here, a specific challenge is to provide stories where the geographical objects vary little over a long period, such as when traveling through large forest areas. The approach of using face-to-face meetings relies on the establishment of a critical mass, where the experience is dependant on the number of co-located players. In other words, no surrounding players, no gaming experience. Hence, this approach would preferably be combined with any of the other two approaches to create a comprehensive experience. It would even be favourable to consider a combination of all three approaches.

Attaining a satisfying order and pace of game-events

The prototypes differ in how they order and pace game-events (see figure 22). Game events in Backseat Gaming are manually linked to pre-selected location or object along the route. The order and pacing of the game-events is only influenced by the speed and the direction of the car. The implementation enables the designer to have control over the delivered content at a specific location, but it lacks in mapping the game content to the temporal unfolding of the journey.

Backseat Playground and Road Rager on the other hand, automatically adapt game-events to the road-context as the players transgress through the road network. However, there is an important difference between the two implemented solutions. As Road Rager applies a repetitive experience at each object, the Backseat Playground forms a dynamically evolving experience which fits with the sequential unfolding of the objects. Which game event that gets executed, and where depends on available roadside objects, where the player has been, her speed, and what she has done in the game. The design provides a rather generic solution for how the game is mapped to surrounding objects. This also mean that the game-content is not as explicit and context descriptive as in Backseat Gaming. Backseat Gaming will for example refer to a certain house as “the small red cabin” to illustrate its specific properties, while in Backseat Playground the same object is only referred to as “the house”. The game executed in different ways during the user trial although the test path was the same. This occurred since the players interacted in different ways, and because the vehicle travelled with different speed. Regardless, the players made sense of the different episodes as part of the overall narrative. However, the players occasionally had difficulties to associate fictive content to several sequentially appearing locations, such as hearing a gunshot at one location and then associate the executed act to a location appearing somewhat later. The movement of the vehicle also contributed to variations in the pacing of game events. The pauses in between the events were occasionally felt as monotonous by some players. However, the players also made it clear that being patient and ready for sudden action was part of the job as an agent. Accordingly, the theme of the game, i.e. the crime mystery genre, made an uneven and sometimes suspended pacing meaningful. Interestingly, the user study of the Backseat playground also indicated that the speed influenced the players’ understanding of the story and hence also the overall sequential experience. When the vehicle was standing still during an intense moment in the game, the players’ interpretation of the event differed compared to players who were moving in high speed during that particular game script. It appeared as if a lack of speed made the player feel more exposed and vulnerable, than if the vehicle was rolling. Thus, high speed contributed to a feeling of confidence where the player felt more in the role of an observer, while standing still suddenly would turn the player into a victim. It follows that the players’ velocity should be regarded as an important design material when designing the actual game experience.

Traffic safety

Finally, we acknowledge that the success of journey games depend on the possibility to enable solutions which do not interfere with traffic safety. At the same time, this has not been an explicit concern in the research presented in this thesis. We have only implicitly applied a safety model where we aim to interact with the driver and the driving as little as possible. For example, the game should be designed in a way that does to demand assistance from the driver. The player should not gain by deliberately changing travel route or driving style. Thus, the safety effects of journey games need to be investigated further.

Chapter 8

Conclusions

This thesis set out to investigate the design space for journey games. The aim has been to gain insights into this novel application area and to understand the potential and implications for design.

Our research reveals a context of use suitable for digital experiences. The player's uncontrolled movement in physical space provides for a continuously changing scenario, which can act as a great resource for manipulative challenges in a game. Additionally, the cursory experience of the road context creates a mean to twist the local meaning of objects. Hence, the uncontrolled and sequential unfolding of the road context provides a fascinating setting for a fiction. Consequently, we argue that journey games are not simply a variation on pervasive gaming, but can also be regarded as a novel kind of experience with qualities that resembles not only computer games but also dark rides and linear media, such as film. The study of the user trials shows how the speed of the vehicle and the characteristics of road-objects formed the game experience in different ways. Hence, we conclude that the dynamic and vivid context of road travel provides a rich material for the designer to work with, and provides a potent means to add drama and challenge to digital experiences on the road.

The work presented within this thesis inspires to think further about future use and application of the concept of journey games. Travelling in a car entails an obligation to sit still, sometimes for an undecided period of time. This extended period of physical inactivity is often perceived as being boring, especially by children. Our research opens up a possibility to engage children more into the journey experience where objects and places along the journey would get a new meaning. A field might not just be a field anymore, but be recognised as the place where a big battle took place or where a big treasure is buried. People might even find pleasure in taking routes that would normally be regarded as dull. An industrial area might suddenly turn from being a boring grey zone to suddenly gain new exciting proportions as part of a game. We have explored the design of games as a means for amusement and entertainment. However, it is easy to also imagine other possible use, such as e.g. for learning. In this sense the children can use their travel time to learn about geographical places or history. The thesis has only scratched the surface of this new and exciting design space. Regardless, we believe it provides a rich source, which we hope will inspire to future work in the area.

Summary of technical papers

The second part of the thesis, chapter 9 – 13, consists of previously written material. In summary the papers report on the conceptualization, design and implementation of the earlier presented prototypes. They also present feedback and results from the conducted user trials. In the following section we will provide a brief introduction to each paper and a note on this author's contribution to the work being presented.

Chapter 9: Backseat Gaming

Brunnberg, L., and Juhlin, O. (2003) Movement and Spatiality in a Gaming Situation - Boosting Mobile Computer Games with the Highway Experience. In Proceedings of Interact'2003 - IFIP TC 13 International Conference on Human-Computer Interaction (Zürich, Switzerland, September 1-5, 2003). IOS Press, pp 407-414.

This paper reports on the design, implementation and user trial of the Backseat Gaming prototype. The paper discusses what roadside objects could be of use to create an understandable and engaging pervasive game and present initial user feedback on the gaming experience.

This author's is responsible for conceptualizing, designing and implementing the game prototype. The author's contribution to writing the paper is equal to the co-author and names are listed alphabetically. Also the practical work of arranging the trial and analyzing the data was done in a collaborative fashion.

Chapter 10: Road Rager

Brunnberg, L. (2004) The Road Rager: making use of traffic encounters in a mobile multiplayer game. In *Proceedings of the 3rd international Conference on Mobile and Ubiquitous Multimedia* (College Park, Maryland, October 27 - 29, 2004). MUM '04, vol. 83. ACM, New York, NY, 33-39.

This paper describes the design and implementation of the Road Rager prototype and reports on a small performance test. The design addresses how different kinds of contingent traffic encounters can be used as resource for a pervasive game. Furthermore, it addresses the prospect of enabling a blended interaction when the time available for identification, exploration and manipulation is very restricted.

This author has been part of the design of the game. Moreover, this author has conceptualized, and implemented the game, built the prototype as well as performed the performance test.

Chapter 11: Road Rager user trial

Brunnberg, L., and Juhlin, O. (2006) Keep your eyes on the road and your finger on the trigger - Designing for mixed focus of attention in a mobile game for brief encounters. In Proceedings of the 4th International Conference on on Pervasive Computing (Dublin, Ireland, May 7-10, 2006). Springer Verlag, 169-186.

This paper reports on a user trial with the Road Rager prototype. It presents user feedback on the general experience of the concept and the possibility to enable blended interaction.

This author's contribution to writing the paper is equal to the co-author and names are listed alphabetically. Also the practical work of arranging the trial and analyzing the data was done in a collaborative fashion.

Chapter 12: Backseat Playground

Gustafsson, A., Bichard, J., Brunnberg, L., Juhlin, O., and Combetto, M. (2006) Believable environments: generating interactive storytelling in vast location-based pervasive games. In *Proceedings of the 2006 ACM SIGCHI international Conference on Advances in Computer Entertainment Technology* (Hollywood, California, June 14 - 16, 2006). ACE '06, vol. 266. ACM, New York, NY, 24. Also to appear in the forthcoming issue of the ACM Computers in Entertainment.

This paper reports on the design and technical implementation, as well as a small performance test, of the Backseat Playground prototype. The design addresses the prospect and challenge of creating a believable environment. Particularly it explores how to provide sequential storytelling that fits with the journey experience and how to scale the game environment through integration with increasingly available digital maps.

This author has been part of the conceptualization, design, implementation, and the writing of the paper. In particular, this author has been responsible for implementing the game and modes of interaction. This paper won the best paper award.

Chapter 13: Backseat Playground user trial

Brunnberg, L., Gustafsson, A., Juhlin, O. Movement and spatial interaction - Inclusion of journey experiences in game play (to be submitted).

This paper reports on a field trial of the Backseat Playground prototype. The paper particularly investigates how players' movement, i.e. speed and direction, influence the practicalities and experiences of the game.

The effort of writing this paper is shared in a similar manner and authors are listed alphabetically. Also the practical work of arranging the trial and analyzing the data was done in a collaborative fashion.

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Part 2

The papers

Chapter 9

Motion and Spatiality in a Gaming Situation – Enhancing Mobile Computer Games with the Highway Experience[2]

Abstract

The *Backseat Gaming* prototype is a context dependent mobile game. It uses the changing scenery and sense of motion created during car travel to generate a compelling game experience. We discuss what roadside objects could be of use to create an understandable and fun mobile game, with reference to emerging game research as well as theories in highway design. We also present initial user feedback on the gaming experience.

Introduction

Future mobile technology will provide more services that exploit the benefits of mobile life (Chincholle et al, 2002). Current mobile games are often portable versions of classic computer games (Kuivakari, 2001). There is also the possibility of incorporating different aspects of mobility to create immersive experiences. We suggest that a mobile game could become especially compelling, if it is aware of the vivid and dynamic mobile context. Car travel is a good example of how the changing scenes and the sense of motion provide for a special experience.

We have developed a context dependent game on a handheld computer. The purpose is to acquire early feedback about how mobile games could benefit from the travel experience. Given the new game concept we

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[2] Brunnberg, L., and Juhlin, O. 2003. Movement and Spatiality in a Gaming Situation - Boosting Mobile Computer Games with the Highway Experience. In Proceedings of Interact'2003 - IFIP TC 13 International Conference on Human-Computer Interaction (Zürich, Switzerland, September 1-5, 2003). IOS Press, pp 407-414.

wanted both to understand the possibility of building a light-version of augmented reality technologies, as well as develop a preliminary theoretical framework for this type of game. The game device is aware of its direction and tilt by means of a digital compass, and its geographical position by means of a GPS-receiver. The player has to attend to stories provided at certain locations, and point the device toward things passing by along the road to make virtual objects appear on the screen.

A central design challenge is to understand the characteristics of the linkage between roadside objects and the game, in order to create a satisfactory user experience. It is essential that users are able to interpret the objects correctly, enjoy the exploration of the game space, and manipulate the relationship in an engaging manner. Initial user feedback shows positive reactions both towards the idea of using road objects and car travel as gaming resources as well as the idea of the roadside as a fascinating game world to explore.

The target group is children who travel in the back seats of cars. They can enjoy the journey and look out of the windows. Often they also amuse themselves by reading, talking or playing traditional context related games where the participants compete by spotting and counting specific objects along the road. Portable computer games have been available as an alternative since the 1980s. A report on mobile multimedia, by Andersen Consulting (2002), shows that mobile games are mostly played during transit, and especially in cars. Now, we can add a new gaming concept to make their situation more enjoyable.

Backseat Gaming

The initial game consists of a framing story and five physical game locations where local stories are told and game manipulation is pursued. The game locations are situated along a four kilometre stretch of road in the periphery of downtown Stockholm, separated by a distance of approximately 800 meters. The children have to find virtual objects at these locations, which are only visible when using the screen of a PDA as a small and virtual window.

Framing story

A story is told when the game starts to provide the player with an understanding of the goals of the game. It is about a scientist who works in a laboratory at the edge of the town. He has succeeded in inventing a special kind of energy. Unfortunately he gets locked out of his lab and finds himself in a parallel world inhabited by other life forms. The player's mission is to carry a virtual key and give it to him as soon as he is found. When the scientist is provided with the key, he can get back into the lab and get rid of the ghosts from the parallel world. The player can see the parallel world through a special device. It works both as a virtual window, that reveals objects in the parallel world, and as a collector of these objects. Many of the virtual objects are malicious creatures, which attack the player in order to grab the key. It is safe as long as the player has enough energy left in the virtual window. If their attacks on the player are successful they get hold of the key and then the lab. Then they would be able to invade our real world.

Fig. 1. Screenshot from local story

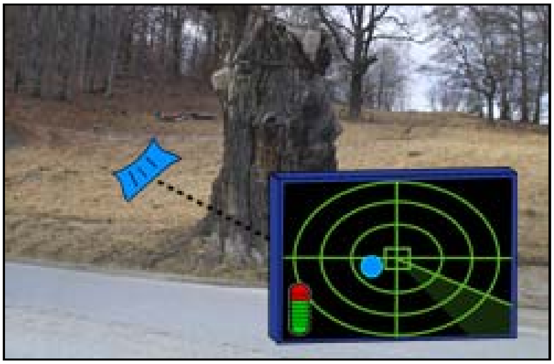

Fig. 2. Description of manipulative event

Fighting ghosts requires energy. Therefore, it is essential that the player have some success, not only at avoiding being killed, but also at sucking energy from the attacking creatures and maintain the energy level. Feedback on the energy level is presented in an energy indicator on the virtual window (fig. 2).

Local stories

The game is designed to make it possible to reach the different game locations in any sequence without affecting the possibility to interpret and engage in a series of manipulative activities. When the car approaches a location it will first trigger a local story (fig. 1). The story is presented by means of pictures of the particular roadside object, overlaid with animations and a narrator voice. It starts well before the roadside object arrives, in order for the story to be completed before the manipulation begins. The story provides instructions about the upcoming manipulative event, which is important since the player is only located near the game location for a very short time. The stories are also intended to make the exploration of the road environment more enjoyable, by interpreting it with reference to a fascinating local story. Figure 1 present a screenshot from a local story that is connected to an old oak tree. It shows an animation of the game character dropping a document by the tree.

Manipulative events

A manipulative event is triggered when the player comes even closer to the location. First, the device automatically changes to window-mode (fig. 2). The player can aim at objects in the physical environment, which have been described in the local story, to find virtual objects. The player must point the device in the correct direction to get the objects to appear in the virtual window. This only occurs if the device is aimed towards their virtual positions in the landscape. Then they must fine-tune the device so that the object, in the form of a big dot, moves to the centre square of the screen. Now, it is possible to attack it and suck up its energy by pressing a button on the device. In figure 2 the device is aimed almost directly towards the virtual object— in this case the document dropped by the game character. Thus the dot is positioned just outside the square.

Combining Highway Experience and Mobile Computer Gaming

The linking of roadside objects to a computer game is the most distinctive feature in the current prototype. In this section, we describe how the linkage is informed by recent game research as well as architectural theories on highway experience.

The game has a traditional relationship between player and computer, similar to a simple combat game (Crawford, 1984). The player manipulates the device to get an object (a big dot, fig. 2) to a specific position on the screen (a rectangle) and then fires at it by pushing a button. However, the game is innovative in the specific ways in which it crosses the normal default separation of the virtual from the real world (Eskelinen, 2001). It becomes a first person action/adventure game only when all the elements are considered in conjunction. As in this type of game, the player enjoys the exploration of the game world as he moves within it and engages in various forms of manipulative events. But in this case, it is a real, and not fictitious, world.

The architects Kevin Lynch and Donald Appleyard have carefully described the special characteristics, which make up the highway experience (Appleyard et al, 1964). It is seen as being a sequential experience, resembling a dramatic play of space and motion. In the beginning of the 1960s, they believed that road construction could be further developed if it was informed by their detailed studies of road user experiences. Based on their findings, road design should be seen as a work of art like architecture, cinema and dance. Forty years later it is also possible to design the highway experience by means of pervasive computing. In our case, we have set out to investigate how the sensation of space and motion during road travel could be used to develop an engaging mobile computer game. The drama of highway experience could be of use. But as the game researcher Markuu Eskelinen argues, to be a game it must also provide compelling manipulative situations where the player's actions are of fundamental importance (Eskelinen, 2001). Thus, the sequential highway experience is used to provide both drama and manipulative challenges to the game.

Backseat Gaming violates the traditional separation between game and world since spatial relations in the game are caused by geographical positions in the outside world. According to Eskelinen, spatial relations are *interpreted, explored* and *manipulated* during a game play. In the following, we will discuss these aspects when selecting roadside objects.

Roadside objects: distinction, location and meaning

We are concerned with objects' size, the possibility to discern them from the background, their distance from the road, and the meanings they convey. How do these characteristics affect interpretation, exploration and manipulation?

First, objects are selected from an interpretative perspective. It should be easy to recognise and single out the object from the surroundings, when passing by in a car. The chosen objects are either single items, such as a tree or a house, or an area e.g. an allotment or a gas works. Areas are easier to distinguish than smaller items. But the choice of objects must also be considered in terms of adequacy for manipulation. The player has to know where to look when aiming. A virtual object can be more difficult to find if the player is uncertain where to look within the physical object. The player has to find exactly the right spot in the area to look to find the virtual object. We believed that it would not add to the gaming experience to search the whole area just for one virtual object. We have therefore chosen to add multiple virtual objects on large physical objects. This is hereafter referred to as a *patch event* since the virtual objects can be seen as a number of patches on a large roadside body. Examples include an allotment area inhabited by several virtual creatures or a gas works area containing virtual tools. *Wrap events* consist of a singular virtual object tied to a specific physical object, e.g. a virtual document dropped at an old oak tree, or a ghost inhabiting a cottage. They provide for different manipulative challenges when finding the virtual objects at a specific area and aiming at them.

Second, the objects chosen were located close to the road, at about ten to fifty meters distance. The proximity adds to the sense of motion, which is central to the highway experience (Appleyard et al, 1964). However, the time for identification and manipulation is decreased making game manipulation harder. Further, most of the real objects chosen were placed on one side of the road, rather than on both sides. The allotment was an exception, where the player travels through the object and gets surrounded by virtual objects. According to Lynch, the latter type of object creates a specific sense of drama, which affects the road experience. Again, the positive experience of exploration can make the gaming manipulation trickier.

Fig. 3. A gasometer

Fig. 4. An oak tree

Fig. 5. A little cottage

Fig. 6. An allotment

Third, the objects were chosen to convey a specific meaning. It had to be easy to refer to them in a local story, and for the player to locate them by the roadside. We assumed that players would easily understood the meanings of concepts like "old oak tree", "red cottage" and "power plant." Further, the game would benefit if the objects were interesting elements even within the traditional highway experience.

There is an element of prying in looking out of car windows: "(t)he sight of activity, or a sense of the meaning and use of areas, is an important pleasure of the road." (Appleyard et al, 1964). Therefore, we chose objects like a power plant, a cottage, and a gasometer, which evoke questions concerning their everyday use. Finally, the objects have a meaning in the game stories.

We have chosen to use the everyday meanings of objects, and make the game story fit with them, in order to balance requirements regarding interpretation, exploration and manipulation. The magic of the objects is created in the way the objects' traditional meanings are used as elements in the game stories. An alternative would have been to ascribe new meanings onto specific objects (Björk et al, 2001). The cottage could be referred to as a space rocket etc. However, we have only invented new meanings for objects if the players almost certainly lack a clear understanding of what the object is, e.g. when making a gasometer into the lab of the main character.

Implementation

A prototype has been built to gather initial user feedback. The game is implemented on a Pocket PC equipped with a GPS receiver and a digital compass module (fig. 7). The compass provides heading, as well as roll and pitch output. Data needed to run the game is locally stored in a database. This makes it very easy to provide content into the game.

Fig. 7. Hardware

Fig. 8. Gaming device

Software architecture

The game engine continuously receives the players positioning data and speed from the GPS receiver. This information is sent to the mapping thread (fig. 9), which compares it with information stored in a database and decides when the game engine should trigger each event. The database contains the following data:

- Type of event, real object's latitude-longitude co-ordinates, radius of manipulative area, Rm (fig. 10)
- Latitude-longitude co-ordinates, number and type of virtual objects located at a real object.
- Information about which local story belongs to which real object and its duration in seconds.

Each story is a self-contained animation sequence.

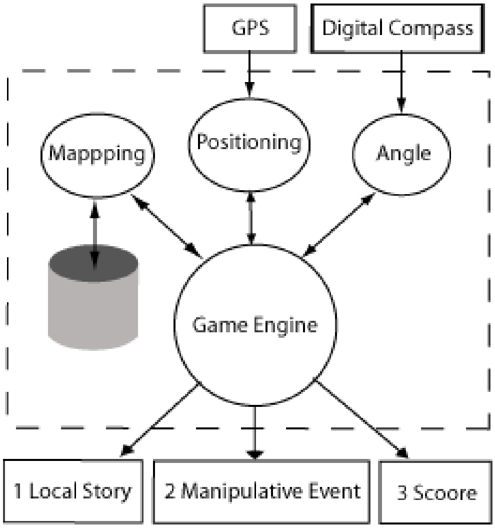

Fig. 9. System architecture

The game typically proceeds through a series of three different modes when the player passes a game location (fig. 10): a local story mode (1), a manipulative event mode (2) and a score feedback mode (3).

1. A local story is activated if the player is at distance, Ds + Rm, from a real object. The distance is calculated by the mapping thread, which accounts for the speed and time needed to present the story. The local stories are created in Macromedia Flash and saved as Flash Player files.

2. A manipulative event is initiated when the player reaches the pre-set distance, Rm, from a real object. Manipulative events can be either wrapped or patched. The virtual object's co-ordinates are found in the database at a wrap event. The co-ordinates are randomly generated within the distance of Rm at a patch event. When a manipulative event is activated the game engine starts reading the heading and tilt angles of the device from the digital compass. The desired aiming direction towards virtual objects is achieved by continually calculating the bearing between the co-ordinates of the player and the real object. The bearing is defined as the angle measured horizontally from north to the direction of the object co-ordinate. Where on the screen the game engine should visualise the object depends on the difference between bearing angle and heading angle of the device and its tilt. The virtual object will be visible on the screen if the heading difference is less than 45° and if tilt is within ±25°. This is the field of view of the virtual window.

3. The manipulative event ends when the player is outside of the pre-set distance Rm from the game location or as soon as all the virtual objects are caught. The player is then provided with feedback on gaming status and score.

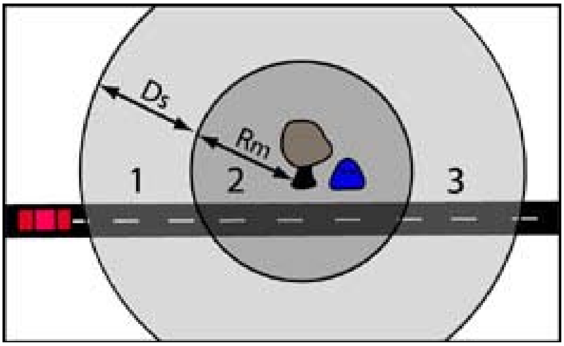

Fig. 10. Events at a game-location

Initial User Feedback

Method and Setting

Evaluation of games must focus both on ease of use and fun of use (Wiberg, 2001). It is not appropriate to evaluate game concepts with regard to the time it takes for a specific playing task. In contrast to work oriented service, an enjoyable game should be easy to understand but difficult to master (Malone, 1984). Therefore, we must find other ways to acquire feedback on how users enjoy, understand and handle the game.

The test took place in a realistic setting. Initially all the participants received an explanation of the game. Two girls and two boys, between the ages of five and ten, each played the game twice. Their activities were video recorded. The recordings have been coded and analysed. We studied facial expressions, general appearance, movement of device and gaze, aiming, firing behaviour and spontaneous comments at each event in the game. Careful analysis of visible behaviour increases the possibility of understanding their appreciation and skills. Asking the children questions about the game experience tends to be unreliable, as they often want to please the researcher (Hanna, 1997).

Understanding the game

General understanding and manipulability

Initially, all the children hesitated before accepting roadside objects as part of the game. This was visible in how they constantly focussed their gaze on the screen. One of the boys, who was only five years old, never understood the idea of connecting the game-play with real world objects. The older three children changed their behaviour after a while. Two of the players understood the game concept rather quickly i.e. they made a connection between the game-content and the physical surrounding outside the car. It took a bit longer for the third player.

Their understanding that the game included the road setting was visible in the ways in which they looked for objects outside as soon as they were referred to in a local story. The oldest boy got the most immersed in the game. He even avoided aiming the sight towards the supposed object if any other physical object, e.g. the car seats in front of him, were in the way. This indicates that he thought of the virtual creatures as really being on the roadside. Thus the fictitious connection was successful.

The three oldest children managed to find and hit virtual objects at least a couple of times during the game. Two players were very successful during their second round and managed to hit almost every virtual object they passed. The third player was less successful but managed to score a hit once in a while. We concluded that it was possible for the older children both to understand the game concept as well as manipulate the device successfully.

Interpretation of Roadside Objects

In general, the players managed to find and interpret roadside objects correctly. But some mistakes were made, e.g. when one boy tried to interpret the meaning of “old oak”. He found it difficult to decide which of all the trees was the oldest one.

Interpretation of Virtual Objects

The possibility of locating an object is an indication of ease of interpretation. They managed to find virtual objects at wrap events with minimal effort, but it was harder during patch events. We expected them to scan both sides of the area with their virtual window when the local story declared the virtual objects to be all around. But instead they sighted in a fixed direction out of the right side window of the car and used the movement of the car to sweep through the area. Possibly they missed information presented in the local story telling the number and location of virtual creatures. The players could more easily find the virtual objects if they were located close to a rather small and concrete roadside object, than if they were patched over a big roadside object.

Manipulation at Patch and Wrap Events

Two of the players soon developed gaming strategies that differed between patch and wrap events. There was a noticeable difference between the ways they moved the device, and how they fixed their gaze, during the two types of manipulative events. During wrap events, such as the old oak and the cottage, they identified the physical object and then aimed straight at it. The angle of the device was continuously adjusted to the position of the car to fine-tune the direction. Their gaze moved back and forth between the screen and the physical object to make sure that they aimed in the right direction. At patch events, they adopted a different strategy. They either aimed the virtual window at a fixed point inside the car, making it sweep through the large roadside object, or at a specific point outside of the car. Further, they fixed their gaze either on the device or out through the window. We suggest that this behaviour could be explained by the larger virtual space to explore in order to find the virtual object. They had to explore the roadside continuously during the whole event. The exploration of the large virtual space was cumbersome. Therefore, they focused either on the screen waiting for objects to show up or out through the window, peppering the environment, without checking whether there were any virtual objects on the screen.

Two players understood the distinction between wrap and patch events and adapted their playing strategies. We conclude that it's possible to build on different relations between real and virtual, where the real objects provide clues as to what virtual objects there could be, and where they are located.

The Enjoyment of Backseat Gaming

General Indications of Enjoyment

The players' facial expressions differed between the first and the second round. Two of the children looked concentrated and serious during the first tour but relaxed during the next round. The older boy became active and involved, which was visible in his expressive facial expressions and body movements. The other child was generally calmer in appearance during both rounds. But there was a noticeable difference as soon as she had understood the game. She said that it was hard in the beginning when she tried to hold the device like a normal portable game, but became fun as soon as she understood what to do. The second girl looked tense all the time, even though she made very positive comments afterwards.

The Fun of Individual Events

The children's level of engagement varied between different events. Their emotional experience will be discussed in relation to the manipulative events and to the local stories. First, the older boy got excited during several manipulative events, and seemed to favour the old oak tree the most. He also said that he enjoyed the two wrap events most. It was easy to figure out where the virtual object was at the old oak tree. At the same time, it provides a strong sense of motion (Appleyard et al, 1964), since it stands at a corner close to the road. The successful girl displayed a more relaxed attitude, as she smiled gently, during many of the manipulative events. The less successful girl looked stressed and didn't seem to enjoy the game very much. Second, the children also showed varieties of emotions in relation to the exploration of the journey as different local stories played out along the way. In general, they displayed amusement with many of the stories, including the framing story. The allotment event, which is a patch event where the car passes right through the game-space, caught most of the girls' attention. This is supported by the research on the highway experience, which suggests that objects surrounding the road generate a special sense of drama (Appleyard, 1964). Here, we also received positive reactions regarding the girls´ manipulation.

To sum up: Backseat Gaming is an amusing and functional game. But it is complex and the players differ in the way they appreciate exploration and manipulation. Basically the fun of use differs depending on whether the players prefer exploration or manipulation. If the players focus on manipulation, they favour wrap events. They prefer patch events if they enjoy exploration most.

Summary of initial user feedback

Our user study provides accurate knowledge about individual gaming situations although the number of test situations is limited. The feedback provides an indication of user experience of mobile context-dependent gaming in a road setting. In general:

- The players succeeded with interpretation and manipulation well enough for us to conclude that the game concept is a plausible design approach.
- They enjoyed the stories in the game. Eskelinen's argumentation for a focus on manipulation in game research should be understood as a part of the game experience and not the whole experience. The balance and variation of exploration and manipulation should be further studied. It would be interesting to design a prototype, which would have a stronger focus on the narration as opposed to the manipulation.
- The roadside objects must be highly distinctive. The choice of ambiguous objects, such as a specific oak tree from among several, has negative effects. This could be a problem on monotonous sections of roads.
- It was hard to convince them that the virtual objects could be located all around the vehicle. They had a preference for the closest roadside. This has consequences for the possibility to play the game going in the opposite direction.
- Using the everyday meanings of roadside objects in the story worked. But it is not possible to tell if it is better or worse than strong integration since that was never evaluated.
- Players developed consistent strategies to cope with wrap and patch events.
- Manipulation is most fun at wrap events.
- Exploration is fun at patch events.
- Manipulation is more fun if it provides a strong sense of motion.
- Storytelling is most fun at roadside objects that in themselves evoke interest, such as places that display activity or dramatic places.

- The game could be hard to understand for very young players even if they are accustomed to traditional computer games. More research should be done into how the game could be more intuitive.

Related work

A number of mobile game concepts cross the boundary between computers and the world. But no game uses movement and direction of the player relative to the surrounding as a resource. Further, no scientific study evaluates the manipulative qualities of context dependent game play itself.

The development of mobile games is being led by industry. And there are a few examples of commercial context-aware games. Cybico's mobile device with wireless peer-to-peer technology supports a number of multiplayer games for people in the proximity of each other (cybiko.com, 030123). Nokia Game (nokiagame.com, 030123) use a variety of channels in the player's immediate setting e.g. the Internet, , email, phone etc. But this setting is very different from the backseat of a car. Botfighters and Supafly from It's Alive use the location of the player as a resource in the game (itsalive.com, 030123). The location is determined with GSM mobile phone positioning, which is too inaccurate to tie game events to roadside objects. Some academic research projects mix virtual game content with the physical space including ARQuake (Thomas et al, 2000) and Pirates! (Björk, 2001). Pirates! is a wireless multi-player game that uses proximity to locations or other players to activate events. It relies on a pre-set infrastructure of beacons to detect proximity. This is not feasible outside of office environments. It should be possible to play Backseat Gaming in a vast environment, where the availability of extensive infrastructure is unrealistic. ARQuake is a technical project seeking to map a traditional game like Quake onto a physical arena. This is achieved by superimposing graphics directly upon the real world using a see-through head-mounted display. These displays are too cumbersome to use. Instead we make use of handheld devices that are less intrusive for the user. Additionally they are becoming more and more available to potential users.

Technically, Backseat Gaming is similar to Websigns from HP (Pradhan et al 2001). This is implemented on handheld devices equipped with a digital compass and GPS-receiver. It links information from the web with physical places by aiming the device toward specific objects in the landscape. Backseat Gaming employs a similar platform but explores its usefulness in the area of entertainment rather than information retrieval.

Conclusion

It is possible to exploit the changing road context during car travel to create a compelling and fun mobile game experience. Research on the unique characteristics of the highway experience can contribute when choosing the most interesting objects to explore. It is important to distinguish between the fun of game exploration, and the fun of game manipulation, since the traditional experience of travel in itself is already so much about exploration. A good manipulative object must instead provide a challenge that requires some physical dexterity. The designers must therefore balance the requirements against each other. A primary focus on either context-aware exploration, or context-aware manipulation, affects which roadside objects to be included in the game as well as how the objects are linked.

Acknowledgements

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Chapter 10

The Road Rager - Making Use of Traffic Encounters in a Mobile Multiplayer Game[3]

Abstract

We present Road Rager, a prototype built in order to explore our hypothesis that proximity and a possibility to identify other players during temporary encounters could spur social interaction and enhance a mobile gaming experience. In this case, it is a multiplayer game designed to enable passengers in different cars to play against each other during a meeting in traffic. Using such meetings as resource opens new interesting possibilities for novel and engaging mobile experiences. In this paper we present the game concept, the implementation and the possibilities to interact - designed to successfully benefit from the dynamic and vivid mobile context created during a traffic encounter. We also present a technical test and some initial user feedback on the gaming experience.

Introduction

Future mobile technology will provide more services that exploit the benefits of mobile life (Chincholle et al, 2002). Current mobile games are often portable versions of classic computer games (Kuivakari, 2001). There is also the possibility of incorporating different aspects of mobility to create immersive experiences. We suggest that a mobile game could become compelling in a new way, if it is aware of the vivid and dynamic mobile context. Travelling along a road means a continuous flow of

[3] Brunnberg, L. 2004. The Road Rager: making use of traffic encounters in a mobile multiplayer game. In Proceedings of the 3rd international Conference on Mobile and Ubiquitous Multimedia (College Park, Maryland, October 27 - 29, 2004). MUM '04, vol. 83. ACM, New York, NY, 33-39.

impressions and new situations where changing scenes, sense of motion and contingent encounters provide for a very special experience. It can be seen as a sequential experience, resembling a dramatic play of space and motion, also called the highway experience. Contingent traffic encounters such as rapid meetings, protracted overtaking or gatherings i.e. traffic jams or red light accumulations constitute an essential part of the experience of travelling along a road (Appleyard et al, 1964). We explore how these meetings, the motion of the accompanying traffic, can be used to create a fun and compelling mobile game and how it can add to the gaming experience. Our hypothesis is that proximity and a possibility to identify other players could spur social interaction and enhance the experience. The target group is children who travel in the back seats of cars.

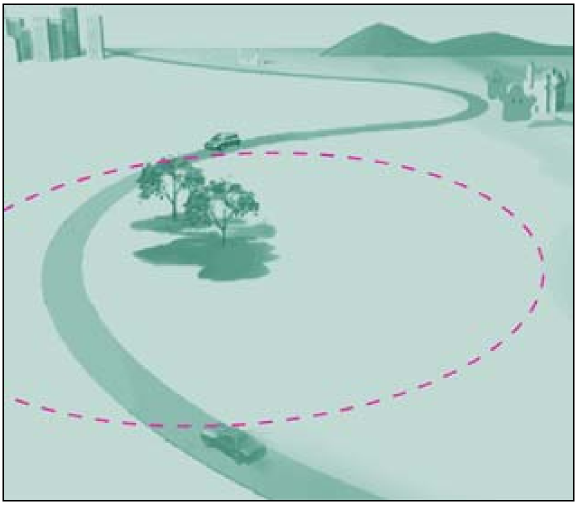

Fig. 1. We explore how contingent traffic encounters can add to the gaming experience.

A game prototype, i.e. *Road Rager*, was created. Road Rager uses wireless ad hoc networking technology to enable game-play between car passengers as they convene within a limited range. Due to high relative speed an encounter can be extremely momentary, sometimes not longer than a couple of seconds. Consequently, a central design challenge concerns the possibility to enable and balance the player's engagement between virtual and real when the time for identification and interaction with the opponent player is very brief. However, drawing on a screen based interface risks having the player focusing on the screen rather than looking out through the window. This inspired us to explore the interaction in terms of a tangible interface. The fictitious connection between the game world and occurring encounters was achieved by means of direction and distance to the opponent player. Additionally, it was important to recognize that traffic encounters occur in a variety of ways, this imply that different kinds of encounters call for different possibilities to interact. When designing the game we chose to focus on three different encounters, i.e. meeting in opposite lanes, overtaking and traffic-light accumulations. Furthermore, the game is designed in such way that it often is rewarding for the player to identify the kind of encounter taking place, in this way we further stimulate the player to engage with the surrounding physical world.

The paper is outlined as follows; we start by presenting a brief overview of traffic encounters and the idea of using them as resource in a game. We then move on to present the concept and the possibilities to interact within the game. Section four gives a discussion on how the game is designed in order to map to different traffic encounters. Further, we present the implementation and a small technical test in order to gain insight into its feasibility. Section seven gives a summary of initial user feedback from a field trial. Finally, we give a brief account for related research.

Combining mobile gaming with traffic encounters

Any road user's journey often coincides with several other journeys. Traffic encounters arise when two or more people on the roads are co-located and are within visible sight of each other e.g. in intersections, passing in opposite lanes or when overtaking (Juhlin, 2001). Encounters with other road-user can occur in many different ways. Due to high relative speed an encounter can be extremely momentary, others more persistent.

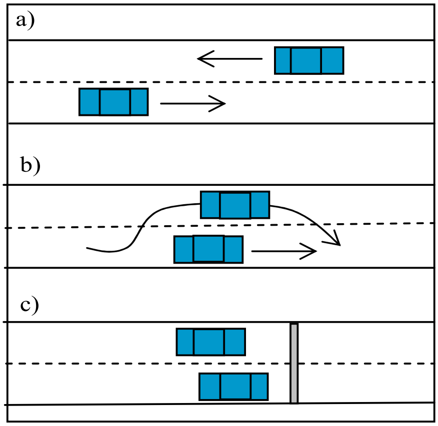

Fig. 2. a) Meeting in opposite lanes, b) overtaking, c) traffic-light accumulations

When designing the game we have focused on three different types of encounters, i.e. meeting of two vehicles travelling in opposite lanes, overtaking and traffic-light accumulations (fig. 2). These encounters were chosen because we believe that they constitute short gaming events but bring about different challenges regarding interpretation, exploration and manipulation for the game-play (Eskelinen, 2001). Encounters where two vehicles travel in opposite direction generally last for a very short period of time, often not longer than a couple of seconds. Overtaking often mean a more protracted co-location than a meeting but contribute to the disadvantage of having another player behind the back during parts of the encounter. Traffic-light accumulation characterise a situation where the players are standing still for a short period of time in close proximity of each other.

Road Rager

Using temporal and unpredictable encounters as resource requires a game-design that takes into account sudden and unpredictable appearance and interruptions between players. A hypothesis is that the possibility to identify other players can enhance the gaming experience and spur social interaction. This motivated several design criteria:

The game should be designed to support the fictitious connection between the game world and the physical world.

- It should support identification, awareness and social interaction between players.
- It should take different situations into account, i.e. it should recognize that different kinds of encounters call for different possibilities to interact.
- It should cultivate the player's fantasy and imagination.

With these design criteria in mind we will in this section present the game concept and the ability to interact within the game.

Game Concept

The game Road Rager consists of a framing story, a set of game level stories and of manipulative events automatically taking place when players are in the proximity of each other. The framing story is told when the game starts to provide the player with the story as well as an understanding of the rules and goals of the game. Game level stories are told in between manipulative events with the purpose of cultivating the fantasy of the game-play. When the game begins the player takes on the role as a character with magic powers. The player's goal is to gain as high power as possible before getting to the big yearly meeting for witches and warlocks. High power can be gained both by achieving knowledge, such as new spells or by gathering powerful objects by being the most powerful in battles. The implementation of the game is currently restricted to game-play between only two persons during a manipulative event. When two players are within wireless reach the game initiates a duel with the purpose of enchanting the opponent. The manipulative event ends if one player gets enchanted or if they get out of each other's wireless reach. If the opponent gets enchanted the player can trade objects and knowledge in possession for more powerful ones. If the connection is broken before any of the players gets enchanted they will receive objects and knowledge dependent on the result of the game-play.

The Interaction within the Game

In order to preserve the connection with the physical world during brief meetings it is essential that the player during these events can focus outside the window of the car rather than on a screen. We have partly used a tangible interface to directly link the digital and the physical world and provide a seamless method of allowing natural physical and social interaction between people (Ishii & Ullmer, 1997). In swift meetings, when the period of time for interaction with other players is limited, the player can concentrate on spotting the other player and act instantly without looking at a screen.

Fig. 3. The Clutcher, a PDA and a Bluetooth GPS

The tangible interface is realized as a magic gadget, i.e. the Clutcher, equipped with fourteen LED's and a button. The LED's communicate certain information relevant for the game-play. Four of these, so-called locator LED's, inform the player about the direction to the opponent player (fig. 4). Ten smaller LED's, so-called power bars, are placed in two rows and are sequentially turned on and off to indicate the amount of magic power the players possess. One of the rows indicates the player's own power and the other the opponent's. The button is for changing tool (see section 3.3).

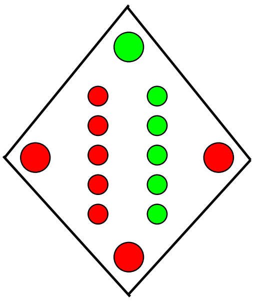

Fig. 4. Feedback LEDs located on top of the Clutcher

To further encourage the player to interact directly with the physical world we use sounds as feedback on the interaction. We also use it as a two-sided feedback, meaning that both players will hear audio feedback as a result of an action. The purpose is to increase the awareness and feeling of presence of the other player and to encourage social interaction.

At the same time as the real world can provide for a rich space where the game can take place it is also important to cultivate the fantasy and imagination of the game and to provide the player with proper feedback and interpretation of the game-play. Therefore we have chosen to use the screen of a PDA as interface in between different manipulative events. The player can then view animated stories related to the game play, the identity of an encountered character, as well as results and status.

Virtual Tools

The interaction during manipulative events relates to the traffic encounters in terms of direction and distance to opponent player. These design parameters are varied to enable the Clutcher to be turned into any of three different virtual tools, i.e. an *Electro squeezer*, a *Sludge thrower* and a *Magic wand*, and are designed to be more or less suitable for the traffic encounters previously discussed (fig. 2).

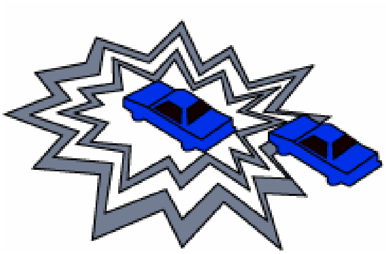

Fig. 5. Sending out electronic pulses with the Electro squeezer

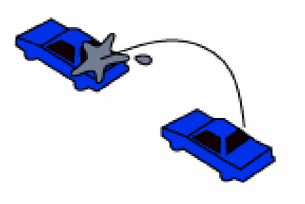

Fig. 6. Throwing sludge with the Sludge thrower

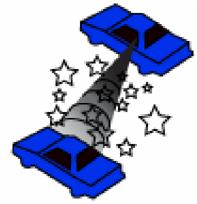

Fig. 7. Cast a spell with the Magic wand

The tool that demands least understanding of the opponent's physical location is the Electro squeezer, based on neither aiming direction nor distance. This tool can be used in a battle without knowing anything about the location or direction to the opponent player, as long as being within wireless reach. It sends out electric pulses and is fired by squeezing the Clutcher (fig. 5). The Sludge thrower is based on aiming direction which makes it more dependent on an understanding of the opponent's physical location than the Electro squeezer. When using the Sludge thrower the locator LED's are active and indicates, if lightened, the direction to the opponent. With this tool the player can throw magic sludge and is used in the same fashion as if throwing something, i.e. the player has to move the Clutcher forward/ downwards at the same time as aiming it towards the opponent (fig. 6). The player will hear a sound indicating that something is flying through the air for two seconds and then a sound indicating hit or miss. The Magic wand is the tool that demands most understanding of the opponent's physical location, being based on both aiming direction and distance. The Magic wand can be used to cast spells (fig. 7). To do this the wand should be swung to follow a circular pattern, but it can only be used once during an encounter. Similar to the Sludge thrower it shows the direction to the opponent player with the help of the locator LED's. It makes use of distance in the way that the closer the player is to the opponent player the more powerful is the tool.

- The Electro squeezer: No demand of aiming or identification
- The Sludge thrower: Aiming but not identification needed
- The Magic wand: Aiming and identification needed

Mapping game manipulation to traffic encounters

The tools and the scoring are mapped to the type of traffic encounter accordingly. The Electro squeezer is quicker and easier to use than the other two tools and require no understanding of direction or identification of opponent. Consequently, the Electro squeezer is suitable for encounters that last for a very short period of time when the interaction time is very limited, such as in sudden meetings in opposite lanes. Additionally, it can be handy to use when it is hard to aim, such as during parts of an overtaking when the opponent is located behind the back. The Sludge thrower is a tool suitable to use at encounters that persist for a while longer such as during an overtaking or at traffic lights. This is due to the procedure of using the tool, which is a bit more time consuming than the Electro squeezer. Similar to the Electro squeezer the Magic wand can be favourable to use in a swift meeting. At a good hit in close proximity of the opponent player it is very powerful. Still, using the Magic wand is also related to a bigger risk of failing. It can for example be difficult to identify the location of the opponent player in time because of intense traffic or dense road networks, such as in a city-centre.

Table 1. Suitability of tools during different traffic encounters

	Meeting	Overtaking	Traffic light
Electro squeezer	Quick and easy to use	Quick and easy to use	Quick and easy to use
Sludge thrower	To slow-bad to use	Easy to use if opponent is in front. Difficult to use if opponent is behind	Easy to use if opponent is in front. Difficult to use if opponent is behind
Magic wand	Difficult to use	Difficult to use, especially if opponent approach from behind	Difficult to use

The reward system is designed so that the player needs to choose tool depending on the encounter in order to be successful in the game. The more connection to the opponent player the tool conveys the more powerful it is. But choosing the most powerful tool is not always the best solution as it also can be difficult to master during certain encounters. Firing the Electro squeezer is very quick and easy but has a low effect on the opponent character. The Sludge thrower is trickier and more time consuming to use than the Electro squeezer but is more powerful. The effect of the Magic wand is dependent on the distance to the opponent player, the closer the more powerful, and is much more powerful than any of the other tools if fired close enough.

Implementation

The game is developed on a PDA equipped with WLAN capability to enable network connection between the players. It is aware of the player's aiming direction by means of a digital compass and its geographical position by means of a GPS-receiver. A Basic stamp II microcontroller controls the LED's and the external button. An additional button is also mounted inside the Clutcher in order to accomplish the squeezable feature. A serial cable connects the Clutcher with the PDA (fig. 3).

Software Architecture

Gaming activity between players during multiplayer events is accomplished through peer-to-peer wireless ad hoc networking, allowing connection between the players without any further infrastructure. Road Rager uses the MongerLib library in order to handle this connection (Östergren, 2004). Mongerlib is based on a rapid mutual peer discovery protocol to quickly detect and connect the players when they meet. It takes care of transmitting and receiving information between the connected devices as well as makes sure the devices disconnect properly when coming out of reach from each other. Furthermore MongerLib also obtain the player's latitude and longitude coordinates from the GPS receiver and handles positioning arithmetics such as calculating distance and bearing to the other player.

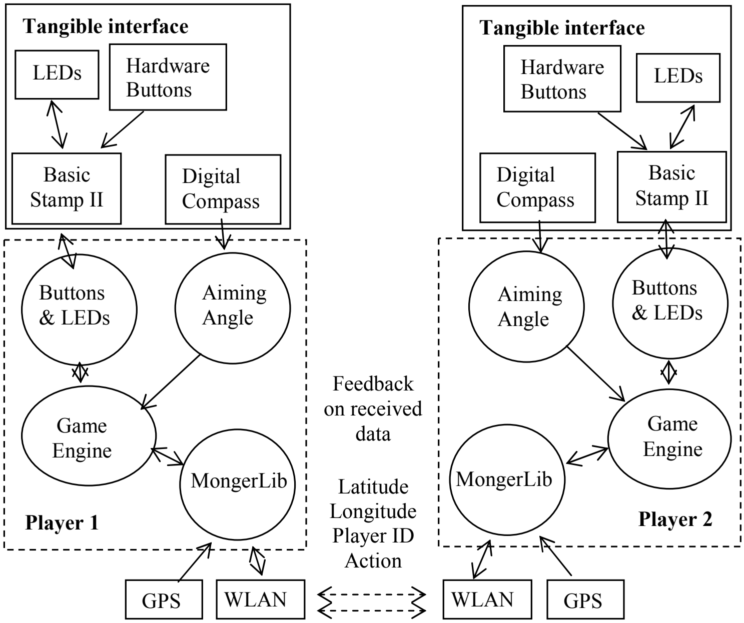

Fig. 8. System architecture (during a manipulative event)

A multiplayer event typically proceeds in the following manner:

- MongerLib detect when two devices are within each other's wireless reach. When MongerLib have established a connection a message is sent to the game engine that will set the game in connected mode. Data can now be sent between the devices.
- As soon as the game is set in connected mode the game engine starts to continuously trigger its present longitude and latitude to be sent to the other device. When the location data is received from the other device the distance and desired aiming direction to it can be obtained. The desired aiming direction is achieved by calculating the bearing between the co-ordinates of the players. The bearing is defined as the angle measured horizontally from north to the direction of the other player's co-ordinate. By comparing this information with the current angle of the compass the game engine sends messages to the Basic Stamp microcontroller to switch on that locator LED which position corresponds to the desired aiming direction, i.e. towards the direction where the opponent player is physically

located. The locator LED's are set to turn on within a range of 45º from the intended aiming direction. Except from the positioning data also information about character identity and of the player performed actions are sent between the connected devices. With performed action we mean if the player fire and with what tool. Rewards for the performed action are not achieved until a feedback on the sent data is received back from the other device. Upon reception of the feedback the magic power is counted up/down and a message is sent to the microcontroller to update the power bar LED's according to the new result.

- MongerLib detects when two devices come out of each other's wireless reach, it then closes down the connection and sends a message to the game engine, which in its turn sets the game to disconnected mode.
- The player is then provided with feedback on gaming achievements on the screen of the PDA.

Technical test

A technical test was conducted in order to investigate if the prototype would perform as expected. The networking capability had already been tested in prototypes such as Soundpryer (Östergren, 2004) and Hocman (Esbjörnsson et al, 2002a; Esbjörnsson et al, 2002b) and proven to work within this setting. A performance criterion critical for the game and important to investigate was rather the accuracy of the aiming direction during a critical situation, such as when the players are standing still in close proximity of each other or during the passing moment of a meeting. The test was carried out in its intended setting and involved a situation where one car passed by a stationary car (fig. 9). The test was monitored from within the moving car. During the test the Clutcher was continuously aimed toward that side of the car where the meeting with the other car eventually would take place, i.e. 90 degrees from driving direction. A camera was mounted to film both the Clutcher and the outside of the side-window at the same time. Afterwards, when looking at the recorded video, a measure of the aiming precision (α) during the moment of meeting could be made. This was accomplished by calculating the distance (x) in meters between the exact moment of the meeting (z) and the turning on/off of the frontal locator LED. The distance was calculated with the help of the speed of the car and the time-encoding of the video. The test was carried out in 50 km/h as well as 70 km/h and the distance (y) between the cars in the moment of the meeting was 10 meters. The LED was set to turn on/off within an aiming range of 22º from the intended aiming direction (fig. 10).

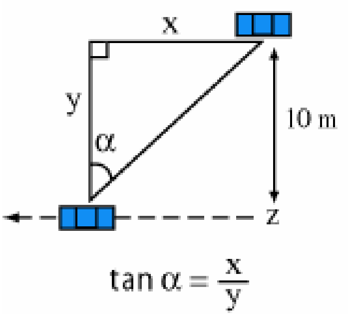

Fig. 9. Test situation

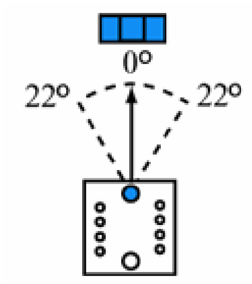

Fig. 10. Aiming rage

The Result

The table below show the results from the test (table 2). A positive number indicates that the locator LED turned on before the point of the meeting and a negative indicates after. The test showed a satisfying result regarding the aiming precision in five out of seven test cases when the car drove 50 km/h. With a satisfying result we mean that the locator LED turned on before or right at the point of the meeting, i.e. it had at most 22 degrees inaccuracy. When the speed was changed to 70 km/h the aiming precision deteriorated considerably. At this speed the locator LED was in all test cases turned on after the exact point of the meeting with an average inaccuracy of 62 degrees. However, as a car at this speed travel 19,4 m/s, this means a lag of 0,43 seconds during the exact moment of the encounter. The aiming range in the game was then change to a value of 45 degrees. A smaller lag was also presumed when the game was designed. With these results we concluded that it would be feasible to carry out a field trial off the prototype, following section will present a summary of user feedbacks from this trial.

Table 1. Test results

	Driving 50 km/h			Driving 70 km/h		
	x (m)	α	inaccuracy	x (m)	α	inaccuracy
1	1,11	6,3º	15,7º	-10,11	-45.3º	67,3º
2	0,00	0,0º	22,0º	-8,56	-40.6º	62,6º
3	3,89	21,3º	00,8º	-9,33	-43,0º	65,0º
4	5,56	29,1º	7,1º	-5,44	-28,6º	50,6º
5	-17,22	-59,9º	81,9º	-7,78	-37,9º	59,9º
6	-1,11	-6,3º	28,3º	-9,33	-43,0º	65,0º
7	-10,56	-46,6º	68,6º			

Initial user feedback

A field trial was conducted in order to discover design flaws and to observe the feasibility of using encounters as resource for the game-play. Furthermore, to get an indication if physical presence and a possibility to identify other players during temporary encounters would spur social interaction and enhance the gaming experience. The test was set up to involve a total of fourteen children, seven children in the age of eight and seven children in the age of ten. The two age groups played the game separately for approximately thirty minutes. Three cars drove simultaneously along a preset route with two to three children in each car. This ensured encounters with other players as well as made it possible to observe the game-play. Initially all participants got an explanation of the game. The activities were video recorded and an interview was carried out after the game-play. Unfortunately, because of certain technical problems, the test cases turn out to be fewer and the game-play sometimes uneven, but they are nevertheless valuable results that indicate possibilities and flaws for the coming evaluation.

Fig. 11. Kids playing Road Rager

It was clear both from the interviews and from observations of the players' behaviors and expressions during the game-play that these temporary encounters created a very thrilling gaming situation. This was not just the case for the player in charge of the Clutcher, but also for the rest of the children in the car. As these gaming events occurred suddenly and often during short periods of time it was usual that all children in the car were involved trying to spot the opponent and to suggest what tool to use. It was also usual that the children divided tasks in between each other so that one was in charge of the PDA and one of the Clutcher or that one was in charge of the game manipulation and one of the searching for the opponent. Situation also occurred when several children held the Clutcher at the same time trying to help each other. Many children mentioned in the interviews that it was the feeling when someone was in the proximity and the searching for the opponent that was the most fun and thrilling part of the game. Equally, they also mentioned that one of the worst things was if they didn't manage to visually spot the opponent. Another thing that they mentioned as fun was the way they could move and manipulate the Clutcher in order to play the game.

After some experimenting, the majority of the children quickly got the idea of how to manipulate the Clutcher during the encounters and how to interpret the feedback from the LEDs. The tools that were most used during the game-play was the Electro squeezer and the Sludge thrower. Even though several children from the beginning had decided that the Magic wand was the most useful one they soon changed there minds. None of them got the concept of waiting until they where close up before using it, which resulted in disapproval. The tool that was generally considered as the most fun to use was the Sludge thrower, but it was often exchanged by the Electro squeezer because of the difficulty to aim during certain meetings.

Related work

Exploring the possibilities of using traffic encounters as resource in a game is one aspect of a bigger adventure game intended to combine game-play with the highway experience. One prototype has already been developed, called Backseat Gaming, which investigate how to integrate roadside objects as part of the gaming experience (Brunnberg & Juhlin, 2003).

The possibility of using the physical world as game-board has been explored for several year by the industry. Commercially available Botfighters from It's Alive (itsalive.com – verified 1st July 2004) use mobility, location and proximity of players as a resource in the game. Road Rager is related to the ideas of Botfighters but explores the impact of proximity during temporary moments for the gaming experience. In Botfighters location is determined with GSM mobile phone positioning, which gives relatively high positioning inaccuracy making it highly unlikely that the players would ever meet while playing the game.

A number of research projects explore the idea of integrating tangible, social and human to physical world interaction into digital and ubiquitous games (Björk et al, 2001; Cheok et al, 2002). These projects are designed for use in a pre-set room and exploring the possibilities of using true mobility as a resource in a gaming constitutes a different design challenge. Examples of games that draw on the other players' physical proximity without any preset infrastructure include PacMan Must Die and Earth Defenders (Sanneblad & Holmquist, 2003) but these games are designed for use during longer periods of co-location of the players and not for short occasional encounters. An example of a game exploiting issues of incorporating different aspects of mobility and the physicality within the experience in an outdoor setting is Can you see me now? (Flintham et al, 2003) This game explores collaboration between online participants and mobile participants on the street.

Conclusion

We have presented a game prototype, designed to make use of contingent traffic encounters as a resource, in order to explore our hypothesis that proximity and a possibility to identify other players during temporary encounters could spur social interaction and enhance a mobile gaming experience. We have also presented a technical test and some initial user feedback on the gaming experience. Important design criteria include how to support the fictitious connection between the game and the real world and simultaneously cultivate the player's fantasy and imagination, how different kinds of encounters call for different gaming situations and how identification, social interaction and awareness could be supported between players. The initial user feedback gives a strong indication that encounters and the motion of the accompanying traffic, occurring during car travelling, can be used to create a compelling and fun game. The user feedback also indicates that the possibility to identify other players can spur social interaction and enhance the gaming experience. This result motivates us to proceed with our research and future work includes an extensive user evaluation of the prototype.

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Chapter 11

Keep your eyes on the road and your finger on the trigger - Designing for mixed focus of attention in a mobile game for brief encounters[4]

Abstract

In this paper we present an initial user feedback study of the Road Rager prototype. Road Rager is a mixed reality game, designed to enable passengers in different cars to play against each other during an encounter in traffic. We are concerned with how to design a game which balances the player's focus of attention between traffic and the computer interfaces, to provide a game which is comprehensive, interesting and challenging during a very limited lifetime. The study shows that a tangible user interface enables the player to handle the interaction in the game while watching for cars in the vicinity. Further, the users found multiplayer gaming during brief encounters exciting. However, the study also showed that minimalism is critical to the design. The gestures should preferably be indexical rather than symbolic, and elaborate forms of identification as a condition for manipulative success should be avoided. Finally, tangible user interfaces also allow a type of gaming where players only focus on the computers' interface, which suppresses the experience of combining traffic interaction with computer interaction.

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[4] Brunnberg, L., and Juhlin, O. 2006. Keep your eyes on the road and your finger on the trigger - Designing for mixed focus of attention in a mobile game for brief encounters. In Proceedings of the 4th International Conference on on Pervasive Computing (Dublin, Ireland, May 7-10, 2006). Springer Verlag, 169-186.

Introduction

In recent years, a number of studies have focused on the exploration of tangible user interfaces to create augmented reality games (Brunnberg, 2003; Nilsen et al, 2004; Thomas et al, 2000; Cheok et al, 2003; Ishii et al, 1999; Magerkurth et al, 2004; Mandryk et al, 2002). These studies are concerned with the possibilities for graspable user interfaces to create experiences that mix real life with virtual life. We suggest that this form of interaction is especially suited to multiplayer gaming, which only occurs during brief social encounters in mobile situations. Therefore, we have designed a game prototype, called “the Road Rager”, which includes a tangible user interface. Gaming is enabled by wireless ad hoc networking technology between car passengers as they convene within a limited range.

The choice of a tangible user interface was motivated by the high relative speed of the players, which makes an encounter very brief. Occasionally, such an encounter last no longer than a couple of seconds. We wanted to generate a user interface that can be handled and experienced while watching for cars in the vicinity during this limited time. Screen-centric interaction risks causing the player to focus on the computer, rather than look out the windows, and thus spoils the specific benefits of a mixed reality game. Consequently, a key challenge concerns the possibility to enable and balance the player’s engagement between computer and traffic, when the time available for identification and interaction with the opponent is very restricted. In this paper we present an initial user feed back study of the game. The game was tested by a total of twelve children in three different cars, during three sessions, circling around a route to generate encounters.

Travelling along a road conveys a continuous flow of impressions and new situations where changing scenes, the sense of motion and contingent encounters provide a very special experience (Appleyard et al, 1964). It can be seen as a sequential experience, resembling a dramatic play of space and motion, i.e. the highway experience. Still, passengers look for other opportunities to pass the time. They might read, talk or play mobile games. But mobile games, and car embedded entertainment systems, are often portable versions of classic computer games where the focus is on a screen (Kuivakari, 2001). Thus, gaming becomes a complete alternative to the highway experience. This form of traditional computer game obscures the highway experience, rather than exploiting the journey for fun, exploration, play and creativity. The possibility of incorporating different aspects of mobility to create immersive experiences is therefore still a promise not yet realised (Brunnberg & Juhlin, 2003). Our hypothesis is that a game could be particularly engaging if it included the vivid and dynamic mobile context. Contingent traffic encounters such as rapid frontal meetings, protracted overtaking or gatherings, e.g. traffic jams or queues at red lights constitute an essential part of the experience of travelling along a road (Juhlin, 2001). These meetings can be used to create fun and compelling mobile games and can add to the gaming experience (Brunnberg, 2004).

The purpose of the study is twofold. First, we will investigate the general experience of a concept, which draws on brief social encounters in a game. Here, our initial user feedback study shows positive reactions towards the idea. Second, we will investigate how to afford interaction in use-contexts where the lifetime of the mixed reality is very limited. We will, in the following, discuss how the interaction could be supported by the design of the user interface, the tasks and the reward structures. Our study shows that the challenge of the use-context itself is so difficult that minimalism is critical. Furthermore, the study suggests that neither support nor rewards for real world focus are needed for the players to maintain a visual focus of attention on the traffic. Instead a blended experience between traffic and the computer occurs very much because the players accept and like the experience that playing in the same space allows.

The research is of interest for the design of pervasive and mobile mixed reality applications that include tangible user interfaces. Tangible user interfaces (TUI) were originally developed to close a "gap" between parallel, but related, activities in a real and a virtual world (Ishii & Ullmer, 1997). The problem of providing a proper mixture of virtuality and reality in mixed reality applications has been raised by Trevisan, Gemo et al (2004). They argue that the multiple sources of information available, and the two worlds of interaction, demand that the users make "choices about what to attend to and when." They suggest that we move beyond the first design agenda of creating a seamless, invisible fit where things are blended together, to see mixed reality as consisting of discrete elements between which users alternate. The issue is to design the boundaries to allow alternation but preclude improper mixture. This study contributes a better understanding of how to design such boundaries in situations with very limited "lifetimes" (Koleva et al, 1999). Enabling interaction in temporally restricted situations is an emergent issue when mobile technologies become embedded into “truly mobile” use contexts where people interact with objects and co-located people as they move (Sherry & Salvador, 2002; Juhlin & Östergren, 2006).

Related work

This paper is related to research in the area of *proximity based games*, *augmented reality* and *tangible interfaces*. A number of academic research projects make use of proximity between players as a resource in a computer generated game, e.g. Treasure (Barkhuus et al, 2005), Pirates! (Björk et al, 2001), PacMan Must Die and Earth Defenders (Sanneblad & Holmquist, 2003). This possibility is also exploited by the industry, e.g. the commercially available Botfighters from It’s Alive (Botfighters, 2005). These games are played via the interface of a mobile device using traditional graphical user interfaces, with buttons and stylus as interaction mechanisms. Thus, the players have to choose between looking at their surroundings and engaging in the game. “Can you see me now?” and Bystander (Flintham et al, 2003) are mixed reality games where online participants compete or collaborate with mobile participants on the street. Both games are played via a traditional screen-based GUI. The participants can also collaborate by communicating via a real-time audio channel while moving through the city streets. In this way the participants themselves have the means to co-focus on the game and the physical world.

There are several projects that propose the use of augmented reality (AR) to enhance existing games (Nilsen et al, 2004). Augmented reality is generally defined as “any mixture of real and virtual environments”, but often specifically refers to “see through” displays (Milgram & Colquhoun, 1999). ARQuake (Thomas et al, 2000) and Human Pacman (Cheok et al, 2003) are examples that allow the user to walk around within an outdoor game-space. ARQuake seeks to map the traditional game Quake onto a physical arena. Human Pacman integrated fantasy features of traditional computer entertainment with physical and social aspects. The games superimpose graphics directly upon the real world using a see-through head-mounted display. The accuracy of the overlaying is a critical problem (Azuma, 1997). Calibration errors and lags in the system easily contribute to a mismatch between the two worlds, especially when the viewpoint or the object is moving. This problem would be even more apparent in a dynamic and mobile situation such as travelling in a car, and especially in an application where both the viewpoint and the object are moving in relation to each other. Furthermore, a user study of the Human Pacman system revealed that a majority of the players found the system too bulky and cumbersome.

Tangible User Interfaces (TUI) allow more embodied interaction with the computer. Ping Pong Plus was designed by Hiroshi Ishii et al already in 1999 as a form of "digitally-augmented cooperative play." Table tennis has been augmented with an interactive surface, which incorporates sensing, sound and projection technologies. The players can focus either on real objects, such as the ball, or look at the augmented effects when it hits the table (Ishii et al, 1999). There are a number of projects exploring the field of tangible interfaces and games (Mueller et al, 2003; Magerkurth et al, 2004; Mandryk et al, 2002). However, these games are stationary, and are dependent on a preset infrastructure, such as projectors or tabletops.

The Road Rager

The game is developed for a PDA equipped with WLAN capability. Gaming activity is accomplished through peer-to-peer wireless ad hoc networking, allowing connection between the devices without any further infrastructure. It is aware of the player's aiming direction by means of a digital compass, and the geographical position through a GPS-receiver. A Basic stamp II microcontroller controls LEDs and external buttons on the tangible interface (figure 1).

Fig.1. Clutcher, PDA and Bluetooth GPS

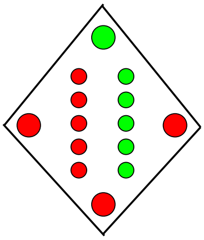

Fig. 2. LEDs on top of Clutcher

The devices automatically initiate a game-event when two players are in close proximity, i.e. within approximately 100 to 200 meters of each other, depending on the surrounding environment. When the game begins the player takes on the role of a character with magic powers. The player's goal is to acquire power in preparation for the yearly witchcraft convention. Power is measured in stars and frogs, which are gained or lost when duelling with other players. A duel is automatically launched when two players are within wireless range. The event ends when one player becomes enchanted, or if they move out of range. If a player charms her opponent, the objects she possesses are traded for more powerful ones, e.g. frogs are exchanged for stars. If the connection is broken they receive stars or frogs dependent on their results up to that point.

It is important to account for traffic safety when designing a game for use in a moving vehicle. This game is therefore intended for passengers in the back seat who are not engaged in the manoeuvring of the car. Still, the game could affect driving if badly designed. Therefore, we have tried to minimize the player's urge to request assistance of the driver. More specifically, there is no support in the game for predicting or making the traffic encounter happen more frequently by changed travel routes or driving styles. Further, it is essential that the player should feel comfortable with the embodied interaction provided by the game, even though they are buckled-up and remain so. However, the discussion in this particular paper is concerned with how the players experience the game per se.

Game interaction

The concept depends on the players' possibilities to look out the windows of the car, and spot the opponents, in conjunction with playing a computer game. Since the time for interaction is limited, these activities have to be tightly integrated. Therefore, we chose a tangible interface. The assumption is that the players can concentrate on spotting each other and act instantly without withdrawing their visual attention from the traffic.

The tangible interface, called the *Clutcher*, is equipped with fourteen LEDs and a button. Four of the LEDs, hereafter referred to as "locator LEDs", are placed in each corner (figure 2) to inform the player of the direction of the opponent. Ten smaller LEDs are placed in two rows. They are sequentially turned on and off to indicate the amount of magic power the player possesses. One of the rows indicates the player's own power and the other that of the opponent. The button is for changing virtual tools (see section 3.2).

We have chosen to use the screen of a PDA as an interface to provide additional information to further stimulate the imagination of the player, and to provide the player with feedback on the results of the duels. The information is not critical for the game-play during an encounter, but is intended to be observed and experienced in between game-events.

Balancing the focus of attention through design

The Road Rager concept is specifically designed to enable what we refer to as a blended focus of attention. Blended attention occurs when the players engage in game-play and interact with the computer in various ways, e.g. to make gestures or listen to sounds, at the same time as they are looking out of the windscreen. We have provided for blended attention through the specific design of the user interface as well as the choice of game characteristics such as tasks and the rewards for fulfilling them.

According to Trevisan, Gemo et al (2004) designers can influence what users look at and interact with by controlling attention through the design of the synchronization and integration of the user interface. Synchronisation refers to the ways in which an event controlled by the system is temporally unfolded. The system can present media, demand input or request a task either simultaneously or in a sequence. Integration refers to choices of what types of interaction will occur, e.g. how the user will receive feedback and how the media are distributed to output devices. Furthermore, integration refers to where the media is presented vis-a-vis the user's attention, i.e. in the central or peripheral context of the focus of attention.

The users' attention can also be influenced through the design of game characteristics such as the way the game is *explored* or how it should be *manipulated* (Eskelinen, 2001). Exploration refers to the players' experience of moving and travelling within the game. In this case, the players' view from the windscreen becomes integrated with that experience, and especially the ways in which they look at surrounding vehicles to *identify* contestants. Manipulation refers to tasks provided in the game, where players actively change the state of "*temporal, spatial, causal* and *functional relations and properties*." According to Eskelinen, a game can do without interesting narratives or other forms of exploration, but it must always have manipulative challenges to be a game. Finally, a specific focus of attention can be afforded by the reward structure in a game.

Three tools (*the Magic Wand*, *the Sludge Thrower* and *the Electro Squeezer*) were designed, which in various ways combine user interfaces, tasks and rewards, in order to investigate the possibilities of enabling and experiencing blended attention.

The Magic Wand (figure 3) strongly requires that the player be engaged in blended attention to be successful. The player has one chance to cast a spell, while very close to the opponent, to get a high score. Therefore the player needs to know exactly who she is contending with. The identification is made possible by the "locator LEDs" on the Clutcher (see figure 1), which give clues as to the direction of the opponent. When the adversary is located, i.e. when she has decided who in that direction she is contesting with, the player visually focuses on that car and makes the gesture when they are very close. It is the most rewarding of the tools if the player identifies the opponent and waits until they are close, which is approximately 20 meters, to cast the spell, to further favour visual identification. If the spell is cast directly after peer connection the gain is only minimal.

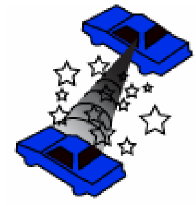

Fig. 3. Casting spells

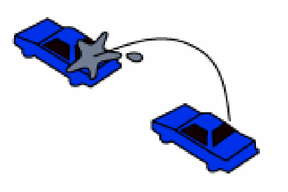

Fig. 4. Throwing sludge

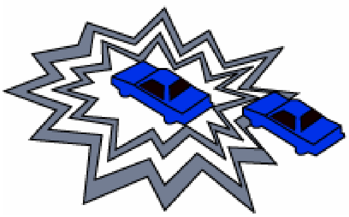

Fig. 5. Triggering electric shocks

The tool affords a sequential order of tasks to be successful. The player must first identify the opponent and then wait until the other car is really close before engaging in manipulation. The user interface is designed to allow a visual focus on the traffic both during identification and manipulation. The player can simultaneously look at traffic and the LEDs on Clutcher as a form of sight, when trying to identify the opponent. The player can continue to look at traffic, while making gestures in a circular pattern to cast a spell, when engaging in game manipulation. Further, sounds are played while the Clutcher is moved, and when the spell is properly cast.

The Electro Squeezer is designed with minimal demands on the player to blend attention, and identify the opponent, in order to be successful (figure 5). It only requires that she recognize that a contestant is within wireless range, which is conveyed by a specific sound, before starting to manipulate. There are no limits as to how many times the player can score but the rewards are small. It sends out fictive electric shocks and plays a specific sound if the Clutcher is squeezed. Thus, there are no demands for either simultaneous or sequential ordering of tasks.

The Sludge Thrower (figure 4) is designed to require interaction with traffic to a degree somewhere in between that of the previous tools. It enables the player to throw virtual sludge at the opponent and score points if it hits. Similarly to the Magic Wand, the process requires that identification and manipulation be carried out sequentially. The design to support identification is also the same. However, the tools have different manipulative tasks. The Sludge Thrower only requires that the Clutcher be aimed towards the contestant to be successful. Further, the integration of modes of interaction is similar to that of the Magic Wand. The player can throw magic sludge, in the same way as if throwing a smaller real object, to score points. The gesture recognition registers when the player moves the Clutcher forward and downward. The player will hear a sound indicating that something is flying through the air for approximately two seconds and then a sound indicating hit or miss. This interaction could be done simultaneously with looking out of the windows. There are no limits as to how many times the player can score.

Method and setting

Road Rager is intended for chance encounters on the road against unacquainted players. These meetings may take place anywhere along the road network. However, in order to ensure encounters with other players as well as to be able to observe the game-play, the field trial was restricted to a preset circular route where the subjects used the prototype during a limited period of time. Each lap took about ten minutes. Fourteen children tested the game. Half of them were eight years old and half of them were ten years old. The two age groups played the game separately for approximately thirty minutes. Three cars drove simultaneously along the route with two to three children in each car. Each vehicle was equipped with a game device and the children within a car took turns playing the game. Before the test, all the participants received an explanation of the game and practiced the techniques of the tools. One or two researchers, sitting in the front seats, rode along in the car during the test. This setup created a number of events where the Road Rager concept was experienced.

The activities were video recorded, and a loosely structured interview was carried out after the game-play, in order to pursue an analysis of the test subjects' visible behaviours and to increase our understanding of their experiences. Video recorders are increasingly used to collect data during HCI evaluations (Hindmarsh et al, 2002). However, as of yet there are no common standards for transcribing video recordings similar to the code schemes in conversation analysis (Heath & Hindmarsh, 2002). Consequently, we have developed a coding scheme that accounts for the details of the children's activities of relevance for this study. Unfortunately, because of certain technical problems, the test cases turn out to be fewer than originally intended, which resulted in recorded material from a total of seven players. These video recordings have been transcribed and coded. We studied facial expressions, general appearance, visual focus of attention, handling of device and spontaneous comments during the game session. Careful analysis of visible behavior increases the possibility of understanding their appreciation and skills.

The test situation was unrealistic in certain ways. The children encountered the same cars several times since the route was circled during the test session. The children soon learnt what they where searching for, which otherwise would be unlikely. However, it also made it possible for us to study the difference in game-play between acquainted and unacquainted encounters. The game is constructed to promote different strategies. This is hard to test during such a short period of time, and would instead require that the players played the game for an extended period of time. The same applies when studying the experience and fun of the game-play in the long run. Regardless, this test provides input of importance for future design both concerning the experience of the game-play and the design of user interfaces for short lived mixed reality applications.

Analysis

We are concerned with how players direct their attention between the visually available traffic situation and the device, in actual gaming, as well as how the game-play is experienced. First, we will analyse how the focus of attention is pursued for each of the tools. Second, we will analyse the focus of attention during other phases of gaming, such as when the player are out of wireless range and during peer connect. The players' comments in the excerpt and the interviews are translated from Swedish. By player we mean the child who is in control of the Clutcher, and by partner we mean another child riding in the back seat of the same car. The opponent is the child participating in the test who is riding in an encountered car. Finally, a game-event is defined as the period during which two devices are connected during a meeting.

Differences between tools

The way the players directed their attention varied between the three tools. For each tool we have structured the material accordingly. First, we discuss whether the players understood how the tool was supposed to be used. Second, we analyse the players' focus of attention during game-play. Finally, we present the players' experience of using the tool.

Casting magic spells. The Magic Wand is designed to require a high degree of visual focus on traffic, in conjunction with a focus on the computer interface. It was difficult for the players to meet these demands as discussed with reference to the following two excerpts:

Table 1. (P=player, F=partner, R=Researcher)

Time	Sound	Hand movement	Visual focus	Comments
10:22	Magic Wand		F look s out P looks at device	
10:26	Connect		F looks out P looks at device	P: aaa
10:27		P lifts the device	P looks out F looks at device	F: aaa
10:28		P moves the Clutcher in a circle	P and F look out through the windscreen	
10:29	Spell			
10:30		F points at a passing car they meet in opposite lane	P looks down at the screen. F looks out through the left window. P quickly glances at F's hand then back to screen	F: there!
10:31			P and F look at screen	P: where?

In the excerpt above the player already has the Magic Wand activated when the game-event begins (10:26). Both the player and the partner quickly look down at the screen when they hear the connect sound. They both look out through the windscreen and the player immediately makes the gesture to cast a spell (10:28). Then he directly focuses on the screen. Not even his partner's pointing towards the opponent drags his attention away from the computer (10:30). He seems confused, which is further supported by his comment "where?" while he is looking at the display and refuses to look where his partner is pointing. Thus, the player casts the spell almost immediately after the connection sound is heard with very limited attempts to identify the opponent. He doesn't perform the tasks of identification and manipulation in a sequence as intended in the design, but rather almost juxtaposes them. However, during manipulation the player simultaneously maintains visual focus out through the windscreen while interacting with the computer, i.e. listening to the audio feedback and interacting with gestures. Thus, here the player blends his focus of attention.

Table 2. (P=player, F1 and F2 =partners , R=Researcher)

Time	Sound	Hand movement	Visual focus	Comments
05:51	Connect		P looks at PDA screen	
05:52	Spell + hit	P moves the Clutcher in a circle	P looks at the PDA screen	P: help!
05:55			F1 looks down at the PDA screen	F2: was it someone who hit us?
05:58	Electro Squeezer hit		P and F1 look at the PDA screen	F1: try and take this one

The excerpt in table 2 presents another type of game-play when the Magic Wand is used. The player has the tool activated before they come into wireless range, as in the previous example. When the connect sound is heard (05:51) the player looks at the screen on the PDA and immediately makes the gesture to cast a spell (05:52). As in the previous case, the player goes straight into manipulation, casting the spell immediately after the connection sound is heard. They display limited attempts to identify the opponent and no delay for the cars to come close enough to get a high score. Then both the player and the partner look at the PDA screen (05:55). One of the partners asks whether they got hit (05.55) and they then get into a discussion on what tool to use next (05.58). However, in contrast to the other case, the player pays no visual attention to the traffic when engaged in manipulation, and solely focuses on the computer screen. Thus the player displays what we term device centric attention. This type of gaming did not fit with our intention to require visual focus on the traffic.

There could be several explanations to the juxtaposition of identification and manipulation as well the device centric attention. It seems like the players understood the concept of the wand in general and how it depended on identifying the opponent and delaying the casting of the spell until they were really close. This general understanding of the concept is visible in other parts of the field test. On one occasion a partner says: "I think we see them ... be prepared...I think we should take the Sludge Thrower, it has better distance than the Magic Wand." Thus, we need to look at other possible explanations. The demand for interaction could be set too high given the brief duration of game-play. Or they could just have become too excited to wait until the contestant was identified and was close enough. However, the concept of a Magic Wand cannot be ruled out altogether since its proper use is difficult to evaluate during such a short field test.

It is not surprising that the players commented in the interviews that they did not like the Magic Wand. Some children had thought that the Magic Wand was going to be the most fun and useful tool before the test. Erik said they had thought the wand would be the best tool "…because you died immediately." However, they soon changed their minds because, as Bill says, "…it didn't turn out that way. You earned more by choosing a less effective tool."

Throwing sludge. The Sludge Thrower provides information on the direction to the opponent and requires that a gesture be made in that direction to be successful. Thus, it provides valuable information on where to look for the adversary, but does not require that they know exactly where in that direction the car is in order to score.

The majority of the children quickly got the idea of how to handle the Sludge Thrower. Most of them practiced throwing sludge when there were no opponents around. There were two ways of using of the tool where the players balanced their focus of attention in different ways.

First we will look at game-play where the player successfully engages in interaction with blended attention.

Table 3. (P=player, F=partner, R=Researcher)

Time	Sound	Hand movement	Visual focus	Comments
23:17	Connect		P and F look at the screen	F: now
23:22		P casts an unsuccessful magic spell	P looks at the screen. F looks out thought the windows and searches actively for opponent.	F: I think they are behind us
23:25		P casts a magic spell	P first looks at the LEDs and then glances out through the windows for a second	
23:27	Sludge Thrower	P changes tool to Sludge Thrower, F points towards the left side-window	P looks at the screen, F looks out thought the windows and searches actively for the opponent.	F: wait! here ...
23:31		P holds up the Clutcher aims towards the left side-window	P first looks at the LEDs and then out through the windows for the opponent	
23:34	sludge + miss	P throws sludge	P looks at the LEDs and then out again	
23:36		F points towards a blue car parked in the opposite lane		F: there was Trollpelle!
23:37	sludge	P throws sludge in direction F is pointing	P and F look in the direction toward the opponent.	
23:39	Sludge-hit		P and F look down at the screen.	P: yes! R: did you get him? P: yes I got him!

During the game-event the player changes tool to the Sludge Thrower (23:27) He holds up the Clutcher towards the windscreen. He looks at the LEDs and then out in the direction designated (23:31). After another quick glance at the LEDs he throws sludge in the indicated direction (23:34). He looks out in that direction as the device plays a sound indicating that it is flying through the air. Thus, identification and manipulation are smoothly performed in sequence two times. Furthermore, the player holds the Clutcher in his line of sight. The player shifts visual focus between it and the traffic. This could be considered blended attention where traffic is in visual focus.

The excerpt in table 1 also displays a collaborative approach to blended attention. The partner is actively searching for the opponent (23:27). He identifies a suspected car and points it out to the player (23:36). The player then throws sludge in that direction (23:39). Thus, the partner makes the identification for the player.

There was also a type of Sludge Thrower use in which visual attention was solely on screen, like that previously discussed. We will, in the following, discuss such a case, even though detailed transcriptions have been excluded for brevity. In this case, both the player and the partner look down at the screen on the PDA when the sound indicating peer connection is heard.

The player holds the Clutcher in her lap. She soon changes her visual focus to the LEDs and throws sludge in the direction indicated by the green light. They meet the opponent driving in the opposite direction and the locator LEDs switch in response and indicate that the adversary is now located behind them. They observe the locator LEDs and turn the Clutcher backwards so that the green LED lights up. Once more she makes a gesture to throw sludge with her eyes steady on the Clutcher. Neither the player, nor the partner, even once look out through the windows during this game-event, but identify the direction to the opponent player simply by looking at the locator LEDs. Still, as in the previous case, their interaction follows a sequence of identification and then manipulation.

To sum up, the Sludge Thrower was both used in a way where the players blended their attention and in way with device centric attention. This was similar to the way the Magic Wand was used. However, the Sludge Thrower provided a more interesting gaming experience than the Magic Wand, since the game-play was often successful and conducted sequentially between identification and manipulation in the way that was intended in the design of this tool. The Sludge Thrower also provided a better experience according to the interviews. Several of the players thought that the Sludge Thrower was the most fun tool to use, even though it was considered somewhat difficult. A player said: “I think the Sludge Thrower is easiest to shoot with…but it is harder to hit with it”. Another player preferred the gesture per se.

We suggest that the difference in success and experience between the Sludge Thrower and the Magic Wand can be understood with reference to the classical semiotic notion of indexical and symbolic signs. The gesture in the Sludge Thrower, i.e. the required movement of the Clutcher forward and downward, can be interpreted as an indexical sign (Fiske, 1982), in the sense that it gets its meaning from the local context. Throwing implies that something in the context gets something thrown at it. In this case, the availability of an adversary in the direction of the gesture supports an interpretation of the gesture as a throw. The spell, on the other hand, is a symbolic sign, which means that it gets its meaning from a social convention. In brief interaction, such as in a traffic encounter, the indexical throw gesture is more intuitive and easier to understand than the more abstract gesture of a circle referring to a spell. When time is brief, and players are excited, it is possible that this minimal difference is of importance.

Triggering electric shocks. The Electro Squeezer requires no visual attention on the traffic for successful scoring. The player only has to pay attention to the sound indicating that an opponent is within wireless range. Then he can directly start to score points by pressing the Clutcher. Consequently, all the children quickly understood the concept.

Again, we identified two types of focus of attention during game-play. We will start by discussing the type of gaming where the players blend their focus of attention. For brevity, we do not provide the transcriptions.

Just before the event the player and partner discuss what tool to use. The connect sound is heard. They look at the screen and the player selects the Electro Squeezer. The partner says “Push! Squeeze! You don’t have to aim.” He looks out of the windows in search of an opponent, while holding up the Clutcher in the line of sight. The player squeezes the Clutcher while looking out. He suddenly says “there!” and then glances down on the PDA screen. He lifts his gaze and smiles, as he continues to squeeze the tool. Both the player and the partner looked at a car, in the opposite lane. The player keeps on squeezing while holding up the Clutcher, aiming it towards the passing car. The partner waves towards the car (see figure 6). In this event, the player engages in what we have referred to as blended attention even though it is not required to score, i.e. he looks out through the windows while simultaneously interacting with the computer.

Fig. 6. Blended attention

Fig. 7. Device centric attention

We also observed a type of gaming where the players' attention was centred on the devices. In the following event, the player and partner immediately look down at the screen as the connect sound is heard (see figure 7). The player holds the Clutcher in her lap and they both look at the LEDs, while she persistently squeezes the tool. After a while the player exclaims "aaa! there is only one left." The player observes the power LEDs, which present the scores in the current exchange, taking no notice of the surrounding traffic.

Thus, the players used the Electro Squeezer in the same two ways as when interacting with the previous tools. The difference is that in this case, the visual focus on traffic, as displayed by the boys above, was not required to score points. We suggest that it occurred since the players found the visual presence of the contestants interesting and fun. In the interviews, the boys discuss the experience of meeting someone physically in a multiplayer game. The best part of the game, according to them, was:

Bill: …the feeling…
Erik: when you met someone…
Bill: …you become sort of … it gets exciting somehow

Some children preferred this tool because they didn't have to aim. The interviews reveal that they considered this to be especially good when something blocked their view of the opponent. Still, for other children this tool was not considered as fun as the Sludge Thrower, because it was only about squeezing.

Additional game interaction

The interaction discussed in the previous section covers events where players are engaged in multiplayer gaming. However, there are other parts of the Road Rager game, where the player does not interact with contestants. First, multiplayer gaming is preceded by a momentary boundary phase (peer discovery) occurring when two cars come within wireless range and the devices discover each other. Second, it is directly followed by a short phase where network contact is dropped (peer loss). Finally, Road Rager is in single player mode during a longer phase where the devices are out of wireless range and the player is waiting for the next game-event. In the following we will discuss how the players focussed their attention in these situations.

Peer discovery. The peer discovery phase, presented through a distinctive sound, is brief and marks the transition from single-player mode to multi-player mode. The sound was supposed to give the player a quick “non-visual” notification to facilitate the immediate possibility of searching for the opponent. All the children understood the significance of this sound. However, instead of looking out the windows or at the locator LEDs in order to locate the opponent, the children most often watched the screen immediately after the connection-sound was heard. This includes both the player and the partners in the car. There are two feedbacks available on the screen that could have been of interest for the players at this moment. First, the screen provides additional visual confirmation that an opponent is in the vicinity, i.e. that the devices are connected, namely a big red square with the text “(name of the adversary character) is in your vicinity”. Second, it provides graphic information about the opponent’s character, consisting of a picture, a name text and the items in his possession, i.e. stars and frogs.

Peer loss. Disconnection of the wireless network was also signalled with a distinctive sound. The result of the game-event was then presented on the screen. This information attracted their attention. All the children immediately looked down at the screen in order to view the result of the game-event. Here the game-play unfolded in accordance with the design intention.

Out of wireless range. The game prototype provided no manipulative challenges when network connection was lost. Still, the children engaged in various related activities. First, they tried out and practiced the different tools available. They experimented with the gestures and listened to the sounds they generated. Second, they looked for contestants. The children maintained a visual focus out through the windows of the car, searching for opponents, during most of the time between the game-events. Interestingly, this search for opponents was also eagerly pursued by the players who mainly displayed device-centric attention during the game-events. This identification work was done by looking for cars with children inside or for colours they thought the opponents' cars had. Looking for cars with specific colours was an activity appreciated by the children and was animatedly discussed. It was also something that was mentioned as a possible improvement during the interviews. A map was suggested where they would be able to see where the other car was and its colour. Third, some players used the Clutcher to "scan" their surrounding by holding it up and sweeping it back and forth, treating it as a kind of "directional radar" able to sense the proximity of opponents. Additionally, if the player occasionally forgot to perform this activity some partners commented on it as being necessary in order to discover the opponents. This was something that the children themselves had come up with, and it indicates that they conceived of there being a fictitious connection between the game and the surrounding physical world. Finally, they settled on the tool to use in the next encounter.

Discussion

Our user study provides initial feedback on how to design for interaction when the boundaries in a mixed reality world are very short-lived and when people move quickly around. The study is a starting point for understanding the possibilities of designing for this context as well as the requirements for doing so.

The interviews and the observations of the players during game-play made it clear that these temporary encounters created a thrilling gaming experience, even for the partners in the cars. Several children mentioned that the feeling when someone was in the vicinity, and the search for the opponent, was fun and thrilling.

We have gained insights into how the users balanced their focus of attention between the traffic and the gaming device. We identified a type of gaming, which was observable in the use of all the three tools, where the visual focus of attention was directed solely towards the screen or the tangible interface, and never out towards traffic. This was a successful form of interaction, in terms of scoring, for the Sludge Thrower and the Electro Squeezer, but a failure when using the Magic Wand. Thus, for those tools, where identification was not necessary, the players occasionally did not engage with the traffic, and even when it was required they still did not do so. In that sense, it was also a failure for the design intention to require players to identify the opponent and thus engage in looking at the traffic in those situations. On the other hand, both the Sludge Thrower and the Electro Squeezer were also used in a way where the players blended their visual focus of attention on traffic with engagement with the computer.

The Magic Wand provided for a sequential unfolding of the tasks of identification and manipulation, which was not applied by the players. Instead they went straight into manipulation as soon as the connection sound was heard. Perhaps the pressing situation in those brief encounters pushed the player to go directly to action. We cannot conclude that demands for sequential unfolding of tasks should be completely ruled out in future designs. In game design, the easiest solution is not always the best. However, it is clear that this type of sequence of tasks, which requires a delay for more exact positioning, should not be a general design principle. Further, the Magic Wand, which was designed to require identification, and thus visual focus on traffic, generated the least amount of attention out of the windows. Possibly, this tool is too complex and demanding for the limited time available for game-play in such brief encounters.

The Sludge Thrower provides a both fun and imaginative experience, and we observed frequent occurrences of blended attention. Here, the sequential unfolding of tasks was smoother. Even though it is only slightly different than the Magic Wand, the difference seems to be crucial. First, the Sludge Thrower requires weaker positioning and gives the players many chances to score. Second, the Sludge Thrower recognised an indexical gesture while the Magic Wand recognised a symbolic gesture with a more abstract meaning. Thus, the Sludge Thrower provided a tighter blend in the manipulation, but was more forgiving in terms of identification.

When using the Electro Squeezer the focus of attention was very much on the surrounding traffic, although it wasn't required to score points. Still the players enjoyed it. We suggest that the experience of being able to see the contestant makes a very simple game-play more exciting. Thus, the success of the Electro Squeezer supports the general design concept of drawing on meetings to make a game which is both comprehensive and challenging in an interesting way.

In general, it is difficult to enable game-play when the lifetime of the game-event was so short. There is just too little time to engage in extensive identification before getting into manipulation. There is, of course, a possibility of developing other means to enable strong identification in future research. See-through displays are one alternative, or the use of interfaces on the device in the other car. The remote device could in some way announce that a player was sitting in a particular car.

However, our study also showed that the weak approach to identification was appealing to the children. On several occasions, the players successfully blended their visual orientation on traffic, with a focus on the computer interface. And they enjoyed identifying who they were playing against, even though it wasn't necessary for scoring. Weak identification, in this sense, adds to the exploration of the game landscape.

Furthermore, indexical gestures, such as throwing, make interaction more intuitive. Other examples for future design could be scooping, patting or hugging. These gestures are less complex than esoteric symbolic gestures of various kinds.

Finally, the users on many occasions looked at the screen for additional information than the audio feedback e.g. directly following peer discovery. Although, we thought of the graphical information as rudimentary, and not interesting in itself, it got lots of attention. In future research, it would be interesting to study whether a user interface with even less graphical information would engender more blended interaction.

To sum up, minimalism is critical for success when designing for brief lifetime in mixed reality applications. The features and tasks of the game have to be cut down to the minimum. Even such a meagre task as supported by the Magic Wand was too complicated. Of course, games should not be designed to be easy, but to provide interesting challenges. However, in this case, the challenges of the use context themselves are so difficult that the designer as a first priority should focus on making the concepts achievable. Then, social situations such as traffic encounters, could become new use contexts for mobile multiplayer games.

Conclusions

We have in this paper been concerned with how to combine and balance a player's focus of attention between traffic and a computer, while at the same time providing a game which is comprehensive, interesting and challenging. It seems possible to exploit contingent traffic encounters to create a both compelling and fun game experience. We observed two types of gaming concerning focus of attention. First, a type where the players focused their visual attention solely on the gaming device. Second, a type where they blended their focus on the mobile devices with a visual focus of attention on the traffic.

The study also suggests that neither support nor rewards were needed for the players to maintain a visual focus of attention on the traffic. Instead a blended experience occurs very much because the players accept and like the imaginative activity that playing in the same space allows. Exploration of the physical game space was a highly popular activity, and the experience of seeing the contestant made a very simple game-play exciting. Often the players enjoyed identifying who they were playing against, even though it wasn't necessary for scoring. Consequently, weak identification in the design added to the exploration of the game landscape.

The approach taken in this project is to establish a mixed reality by the use of tangible user interfaces rather than see-through displays. See-through displays strongly influence the user to see the world as a mixed reality, whereas the approach in Road Rager rather depends on the user actively engaging in the creation of such an experience. Therefore it is not so surprising that we find both a type of focus where people mix their attention between traffic and the computer's interfaces, as well as a form of attention where the users did not engage in creating this experience. Still, it is possible to argue, based on this study, that TUIs could be an alternative if used in contexts and for applications where players find it interesting enough to actively contribute in mixing realities. As discussed, the children often interacted with Road Rager in ways in which the traffic, with people and cars, and the mobile technology with its user faces, came to create a coherent reality.

In conclusion, this study suggests that the possibility of enabling interaction within such a temporally restricted mobile situation, and the positive experience shown by the users, motivates further research into support for interaction in brief encounters. We have specifically addressed short encounters where people sit in the back seats of cars. But it is possible to imagine other brief encounters where people quickly move in and out of range, e.g. public transportation, elevators, and ski lifts. Encounters in such circumstances could provide a specific experience if the design of the services accounts for this rather particular use context.

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Chapter 12

Believable environments – Generating interactive storytelling in vast location based pervasive games[5]

Abstract

We argue that the possibility to generate content into vast areas is a relevant challenge in the area of location based pervasive games. In this paper, we present a game prototype that enables children travelling in the back seat of a car to enjoy a narrated experience where game play combines with the experience of travelling through the road network. The prototype is designed to provide, what we refer to as a believable environment. We suggest four design characteristics to provide a persuasive inclusion of a journey into a pervasive game. First, the story should refer to geographical objects with their everyday meaning. Second, the game needs to scale over vast areas. Third, the application should provide sequential storytelling to make it fit with the journey experience, and finally it should provide interaction support where players can engage in game-play and interact with the computer in various ways at the same time as they are looking out of the car window. We describe how these requirements have been implemented in the prototype and present an initial performance test.

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[5] Gustafsson, A., Bichard, J., Brunnberg, L., Juhlin, O., and Combetto, M. 2006. Believable environments: generating interactive storytelling in vast location-based pervasive games. In Proceedings of the 2006 ACM SIGCHI international Conference on Advances in Computer Entertainment Technology (Hollywood, California, June 14 - 16, 2006). ACE '06, vol. 266. ACM, New York, NY, 24. Also to appear in the forthcoming issue of the ACM Computers in Entertainment.

Introduction

In recent years, location based experiences and location based pervasive games, where a users' bodily and spatial movement in the physical world is a key element, has increasingly become a research focus. However, available applications depend on either constant manual work to make the game fit into new geographical areas or lack location based experience beyond navigation support for chasing each other. Furthermore, there is an issue of generating content if pervasive and location based games will scale up beyond limited experimental setups, which has dominated research so far.

In this paper we investigate the possibility to enrich pervasive games by providing more narrated elements in the game, as well as scale the game environment through integration with increasingly available geographical information systems. Recent advancement within interactive storytelling is promising (Crawford, 2005; Mateas and Stern, 2003; Szilas, 2003). First, these engines can extend the scope of pervasive games, beyond simple chasing games, with more complex interaction. Second, these engines could possibly handle the interaction as it occurs through the players movements through the landscape, as an addition to the more active choices pursued within the narrative experience. Furthermore, GIS data is becoming more widely available and accurate. Available map objects can be used for reasons other than supporting navigation. They can be used to link the pervasive narrative game with the surrounding environment.

We have implemented a narrative based game, called Backseat Playground, on a platform consisting of a PDA; a gyro and a GPS receiver, as well as a server running on a lap top which connects to the game device over WiFi. The application provides audio centric interaction which includes telephone and walkie-talkie interaction, as well as a directional microphone to investigate the soundscape surrounding the car. The player acts as a manager for field agents. The technologies are utilised to unfold a crime story with supernatural twists, where the actual location of the car is of importance. The game characters reference geographical objects in the vicinity and the player investigate what is happening with the directional microphone and interact with other characters over the phone or the walkie-talkie.

A journey along a road means a continuous flow of impressions of situations where changing scenes, sense of motion and contingent encounters provide for a very special sensation (Appleyard et al, 1964). It is a sequential experience, resembling a dramatic play of space and motion i.e. the highway experience. We suggest that it is possible to engage children more into that journey experience. Today, and in the foreseeable future, travelling by car is for many families an important part of their mobile life. It is a largely mundane activity involving daily commuting, trips to the weekend house or longer journeys when going on vacation. Children traveling in the car often engage in different means of amusement in order to pass the time. They might read, talk or play mobile games. But current mobile games are often portable versions of classic computer games where the focus is on the interface and screen. Thus, gaming becomes a complete alternative that does not draw on the positive parts of being on the road. This form of traditional computer game rather obscures the highway experience, than exploiting the journey for play, learning and creativity.

The research is also of interest for the research in interactive storytelling, since it reconsiders the role of the stage set and introduces what we will refer to as "the believability of the environment." Researchers have been struggling to build interactive storytelling engines since the 1980's (Crawford, 2005, p 134) However, the crippled experiences have been explained by the difficulties in balancing interactivity and demand on linearity in stories to provide dramatic effects, as well as difficulties in generating believable. New forms of stage sets, such as the landscape as seen from the backseat of a car, could prove to be an area where interactive storytelling makes sense.

Related works

This paper is related to commercial applications and research prototypes in the area of *location based games* and *location based storytelling*.'

On the other hand a number of industrial and academic research projects explore the idea of using geographical locations as a resource in a computer generated game play. The possibility is exploited by the industry, e.g. in *Botfighters* from It's Alive (Botfighters, 2005). Botfighters is a commercially available SMS game, which depends on network positioning and therefore scales easily. The players can track opponents; get their location; move and then fight them using phone cell positioning. But the game does not adapt to the differences between the locations. It will present the same tasks and context and background stories at a graveyard and a motorway. *Backseat gaming* is a mobile augmented reality game that makes use of changing scenery and sense of motion during travelling. The real world passing by the vehicle acts as the world where the game takes place and the game play and the narratives has clear connections to the roadside objects seen outside the window of the vehicle. This game is highly situated, and depends on the designer visiting the road stretch, to make up special stories for each location (Brunnberg & Juhlin, 2003). The research prototype *Treasure* is played between two teams who run around in the physical environment to chase virtual coins (Barkhuus et al, 2005). The coins are placed in the vicinity of WiFi access points, which are selected by the game provider. Thus, the game scales through inclusion of more access points. The game is simple and the content does not change from place to place. "*Can you see me now?*"(Flintham et al, 2003) is a mixed reality chasing game where online participants compete or collaborate with mobile participants on the street. Both games are played via a traditional screen based GUI. The participants can also collaborate by communicating via a real-time audio channel while moving through the city streets. The game can be played where there is availability of high bandwidth networking and digital maps.

In summary, these location based pervasive games relate to geography for navigational challenges i.e. chasing, and manual work is often utilized to enrich map data and make the game scale.

The *Journey* (Journey, 2006) is a simple commercial mobile service, which consists of a linear murder mystery story, where the player switch pages by walking e.g. 50 meters in any direction. But there are a number of more advanced research applications, which in further extent incorporates a players' presence at a geographical location as part of a story. *Hopstory* is an interactive storytelling research application, which depends on infrastructure to provide location based audio stories. Users are offered individual stories when they come in proximity of objects. The static stories are played in the order by which the user arrives at specific places. Thus, the user will experience something like an anthology presented in random order (Nisi et al, 2004). *M-views* is a similar application, which provide media clips dependent on how the user moves through a geographical area. The researchers stress the non-linearity as a specific feature of the story telling (Crow et al, 2003). The *Geist* concept is designed for location based storytelling provided as an augmented reality experience with see-through displays (Kretschmer et al, 2001; Malaka et al, 2004). In particular, the researchers aim for enriching the experience of visiting a historical site with tourist value. The focus in the project has been to provide a scalable video solution, which include positioning through video recognition. The scalability problem emerged when attempting to use such systems in other than geographically confined areas. The application is not only considered for providing historical information, but also for providing fiction. Therefore, the application has tools for authors to put together fact and stories for specific locations. Interestingly, they also identified the possibility to include the user's movements between locations as a form of interaction with the story. They formulate the requirement that "(t)he engine has to ensure that the story keeps unfolding wherever the user goes." (Malaka et al, 2004) However, the end solution, as presented in the concept papers, seems to lack an engine, which provides a story which holds together over the specific "stages".

Thus, several location-based storytelling applications provide narratives, which are rich in detailed references to the specific location where they are being told. However, it would be difficult to generate content for larger geographical areas. First, they depend on manual design labour to invent stories at specific sites. Secondly, they do not interact with the users' journeys. The experience becomes a random sum of visits to locations with embedded stories, which in terms of a reading experience could be described as anthology, rather than a novel.

Journeys and stories

Children travel in the back seat of car for various reasons. They go on routine trips back and forth to schools, or to pursue their leisure actives. They go with their families to shopping centres or to visit relatives and friends. They also follow their parents on longer trips on vacations and weekends. Sitting in the back seat, they have very limited control of where the car is moving, and there is no demand on them to take part in the manoeuvring. They can therefore spend the journey time looking out of the car windows or doing something else. The experience of looking out on the passing landscape has been studied by architects such as Kevin Lynch and his colleagues (Appleyard et al, 1964). They described the journey as a visual sequential experience, which resemble a dramatic play of space and motion. In the beginning of the 1960s, they believed that road construction could be further developed if it was informed by their detailed studies of road users' experiences. Based on their findings, road design should be seen as a work of art like cinema or dance. However, the critical challenge when designing for the journey experience is to account for the individualised path in which the road network is transgressed, which in turn creates a very situated experience. This poses a problem for design at any specific road section. Lynch and his colleagues argued that: "…the audience enters and leaves from different points, or may be proceeding from end to beginning rather than vice versa." (Appleyard et al, 1964, p 53) It follows that it is difficult to design to provide dramatic visual effects e.g. by escalation and relief, when the designer cannot know in what order it will be experienced.

The issue of providing for multiple readings of a designed experience is also a topic in the emerging field of interactive storytelling. It is a research area, which has come into focus in the area of computer games, where better stories could provide interesting experiences (Laaksolahti et al, 2003; Charles et al, 2004). It is defined as "…real-time generation of narrative action that takes into account the consequences of user intervention, by "re-generating" the story as the environment is modified by the user's intervention." (Charles et al, 2004) Research has aimed to resolve the tension between interactivity and the traditional demand on linearity in a plot, to provide dramatic effects such as conflicts and resolutions. Furthermore, the focus has been on providing believable characters with depth and complexity e.g. emotional behaviours (Crawford, 2005). Although, it is too early to say that interactive storytelling has settled the issue of how to balance linearity and user control, the available systems are sufficiently developed so that we can expand the area of research.

We suggest an addition to the ways in which efforts are made to increase the dramatic range of available storytelling systems. We argue for research into the design of the stories "environment", or in other words, the stage set of the story (Crawford, 2005). New forms of environments for interactive storytelling could be an aspect, which make interactive storytelling more convincing. In the following we will refer to this approach as investigating what makes a "believable environment". However, this does not mean taking another step in the direction Crawford refers to as the "environmental approach", which suggests that just more props and larger environments are better. We argue that taking the environmental approach seriously, means to design and investigate new types of stage sets with more complexity than computer generated environments. A first step is to explore the use of new mixed reality interfaces, which include individual geographical locations in the story such as in systems like Geist (Kretschmer et al, 2001; Malaka et al, 2004) or projects such as (Charles et al, 2004). We suggest that an additional step towards understanding the characteristics of a believable environment is to utilize a complete journey, or travelled path, as the stage for an interactive story.

Children appreciate references to road side objects in computer generated narratives (Brunnberg & Juhlin, 2003). The challenge is to develop a narrative engine that utilizes the movement of the vehicle, and the path of the journey, to form a sequential story rather than a random anthology. The concept of journey through a computer generated environment has been used in several interactive storytelling systems to enforce linearity (Crawford, 2005). But then the journey is a pre-designed backdrop which determines the unfolding of the story. There is a major difference between such a use of a journey to provide narrative rigour in a computer game, and using a journey as it unfolds in real-time through a physical landscape

Believable environments

The rationale for the Backseat Playground application is to meet four challenges, to draw upon a journey as a believable environment in location based interactive storytelling.

Geographical objects with everyday meaning. In order to create a believable environment it would be favourable to draw upon the environment as an intrinsic part of a computer generated story. Some game/story objects should refer to physical objects with preserved everyday meaning. By everyday meaning of a geographical object, we mean publicly understandable interpretations of objects. By linking the game intrinsically to such objects, the game will provide possibilities for designing linkages between game-play, narratives and environment.

Scalability over vast areas. Children in the back seat travel over large distances on family trips as well as commuting. Thus, the game must be available over very large geographical areas. In order to allow widespread use of location based pervasive games, we will explore cost-effective scaleable solutions that enable widespread gaming over any territory that has associated digital mapping data.

Sequential storytelling. A believable narrative game, in this particular context, should fit with the journey through the environment i.e. the journey as it unfolds when a car moves through the road network should be a meaningful part of the story a posteriori. Thus, the narrative game engine should provide a temporally continuing story which fits with the dynamically appearing locations in the environment.

For traffic safety reasons, players should not interact with the driver as part of the game. Sudden orders shouted to the driver in excitement could be dangerous and must be avoided. Thus, the player should not be allowed to interact through mobility. Thus, it should be clear to the player that she has nothing to gain from changing the driver's direction.

Blended focus of attention. Belief in story environments could break if the player exclusively interacts with either the computer or the landscape. Therefore we need to develop user interaction support which provide for "blended focus of attention" (Brunnberg & Juhlin, 2006), which occurs when the players engage in game-play and interact with the computer in various ways, e.g. to make gestures or listen to sounds, at the same time as they are looking out of the windscreen. The support for visual focus out of the windscreen, at the same time as interacting with the computer, resembles the requirements for developing car driver support (European Commission, 1998). Following, these European guidelines we suggest an audio centric approach to enable the passenger, in this case, to look out on the environment at the same time as she interacts with the computer.

The Backseat Playground

The prototype implemented to study the design of believable environments consists of *hardware*, as well as architectural modules such as the *world of the story*; a *narrative logic*, a *game event manager*, as well as means for *user interaction* and a *GIS module*.

Hardware

The backseat playground prototype consists of a server running on a laptop; a client (a pocket pc), a gyro, a pair of headphones a Bluetooth GPS receiver, a wireless access point and a 12V – 220V power converter. The player is equipped with a casing of a directional microphone; the pocket PC and the headphones while the rest of the devices are installed at suitable places in the car.

The casing of the directional microphone has been equipped with a Microstrain 3DM GX1 sensor module carrying accelerometers, gyros and magnetometers for sensing orientation and motion in all 3-dimensions. The data from the sensor module is transmitted from the directional microphone to the Pocket PC device by a small Bluetooth module.

The Pocket PC provides both a visual interface through its display, as well as aural interface thought the connected headphones. To communicate with the server it uses wireless LAN. The Bluetooth GPS can be connected to either the Pocket PC or the Laptop. The GPS signal will be relayed over the wireless LAN in either case.

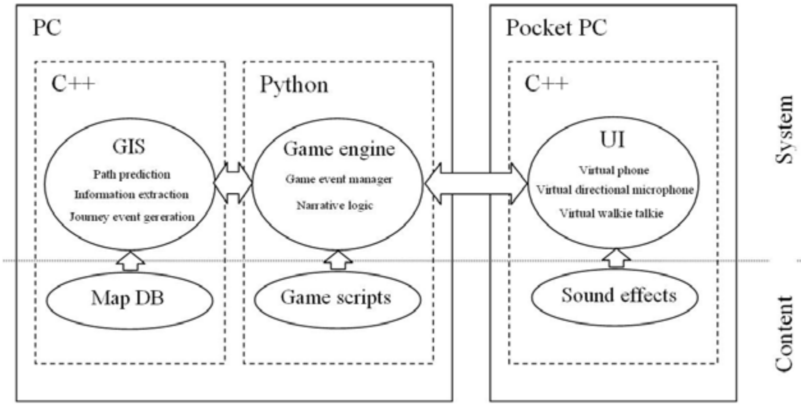

Fig. 1. System architecture

Fig. 2. Devices

User interaction

The user interaction is audio centric in order to demand and support a visual focus on the surroundings rather on some device. The graphical interfaced provided is a therefore minimalistic.

The user interaction is built up around the idea of having a set of virtual devices i.e. a mobile cell phone, a walkie-talkie and a directional microphone. The cell phone and walkie-talkie both provides a mean for the players to keep in contact with the game characters. Both devices use text to speech synthesizing with a number of voices together with a sound effect system to create life like incoming phone calls and walkie-talkie calls. The virtual user interface of each of the device is displayed on the pocket pc when the device is active. After a call an options menu can be displayed in order to let the user select between different action in response to the call.

The directional microphone enables us to give the sound an actual location. It mostly plays sound effects although it sometimes used together with the TTS to let you listen into conversations. The player tunes in to sounds on different virtual locations by turning the microphone around. The direction to the sound is based on data from the direction sensors together with the GPS location. By monitor the players use of the microphone the system will be able to determine with of the sounds the player is listening in to.

Story world

The story is a crime mystery with a supernatural twist. The player is positioned as a detective in a special crime unit, charged with the task of overseeing operations to investigate a series of seemingly related crimes and ultimately to uncover the workings of an organised crime gang. After being introduced to the story with a radio report of a museum robbery, the player is introduced to their partner Helena who is located at police HQ. Helena and the player build a relationship of trust and cooperation. Whilst the player communicates with agents in the field via walkie-talkie, the relationship with Helena is reinforced by being made over the mobile phone. But all is not as it seems, Boss Ulf is aggressive and grumpy: reports of wolves are met with derision and anger and relations between him and Helena become strained as the case develops. So what about the dog hairs in Ulf's office? What of the mysterious deaths of the criminals involved in the thefts of valuable occult related artifacts from local museums. Things take a turn for the worse when a rogue wolf is tracked and shot by agents only to discover they have shot a person. By affecting the moods and relationships between player and in-game characters the players actions unfold a dark adventure. The player decides whether to strengthen their colleagues fight against these dark happenings or betray her partners and help unleash occult forces on the unsuspecting neighbourhood. One thing is for certain, Ulf is not who he seems, and the player has to decide whether she wants to know more.

Narrative logic

The narrative logic is implemented as a set of story scripts, which each contain a separate part relating to the story world. The user interacts with the narrative through active choices, as well as by the movement through the geographical landscape. However, in the choice of providing linearity or user control (Szilas, 2003) the implemented narrative logic tend toward providing linear stories.

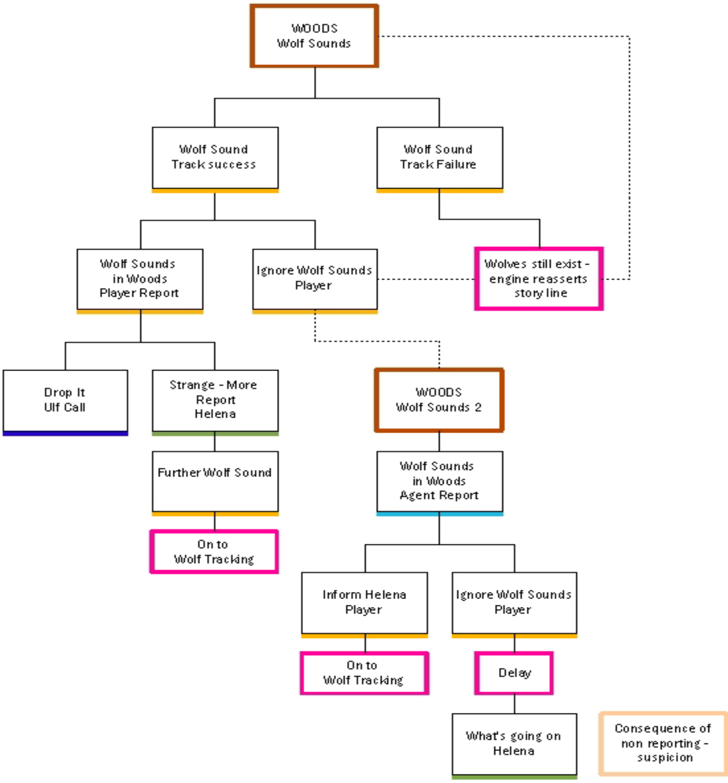

Fig. 3. Diagram showing the wolf encounter script

The logic not only interacts with the users' movements and selections, but also ascertains a well paced unfolding of the script. For example, it keeps track of the tempo between events in the scripts. Lack of available geographical objects could lead to tedious lingering. The requirements on pacing affect the selection of geographical objects for the narrative. First, the logic sets the scripts to trigger on additional types of roadside objects the longer time that pass without match. In this way a script can from the beginning be set to trigger only preferred objects. If time passes without the script being triggered, it will also accept less appropriate objects. Second, it can also decide to trigger events with no local reference at all. Finally, the narrative logic in the scripts rates their own desire to execute at any specific moment of time as well as keeping track of their current state in the narrative plot. This is done by selecting a value from 0 to 100%. This rate is part of the scripts interface to the game event manager.

The test implementation consists of two story scripts. We will in the following describe one possible path through the "wolf encounter" story script's tree structure:

- The first part of the Wolf encounter script is a local event and can be triggered at the objects forest, wood, marsh and nature reserve. When triggered a 3d sound representing a howling wolf will be heard. The player can then use the directional microphone to track the sound.

- If the player manages to track the sound the script will proceed down the tree structure. Two choices will now appear on the screen of the pocket pc, i.e. the player has to choose between reporting about the wolf sound to Helena or to ignore.

- When the player has made its choice the story script is finished with its current event and the game event handler will continue to execute (see section 5.6). If the player has chosen to report about the sound to Helena, the Wolf encounter script will be set to run a global event, which is a phone call from Helena.

- After 120 seconds the Wolf encounter script will once again highly rate its desire to execute, which will prompt the application to forward a phone call from Helena. The player will now see a phone on screen of the pocket pc; hear a phone ring and get the option to answer or reject. If answering the phone the player will hear Helena reporting back about the wolf sounds.

- The previous step will be repeated once again but this time with a phone call from Ulf. After the phone call the Wolf encounter script will once again be set to run a local event on the objects forest, wood, marsh and nature reserve, but also on urban areas.
- When being triggered the player this time will see a walkie-talkie appear on the pocket pc screen and hear two walkie-talkie calls in a row from one of the field agents reporting about the progression of the wolf hunt.
- Depending on the players current location i.e. either being in the urban area or in the waste land, the script will proceed with two different continuations. If being in the urban area the field agent will report back about the wolf being shot but no body found; only blood samples sent for analysis. If being in the waste land the agent will report about a human body being found instead of a wolf. The story script now is finished with its current event and will once again be set to run two global events with phone calls from Helena and Ulf equal to step 5.

GIS module

We propose using widely available GIS location data as a basis for the application, allowing a fictitious world to be constructed around and within the physical environment. GIS mapping data (Crawford, 2005) includes layers of physical objects such as road networks, street signs, buildings and topographic features which can be linked to the game database. The map is processed in a GIS server module in order to predict which objects will occur on the journey as well as their order and pacing during the upcoming movement through the landscape. The map processing converts the 2-dimensional GIS data into a linear series of geographical event that are interpreted by the game event manager. These steps include *prediction of player's paths*; *extraction of visually available information* and *production of journey events through mapping of information onto the predicted paths*. The outcome is a list of journey event objects sorted as they will occur along the path ahead. The list will be the module's input into the event manager.

Path prediction: The first step in matching the narrative to the surrounding geography is to predict how far the car will move in the near future. We make this prognosis based on available route options ahead of the vehicle i.e. in the current direction of the vehicle.

The algorithm starts by searching for a road ahead of the current GPS location, by identifying one of the road boundaries. When a path is identified, the algorithm follows it forward until an intersection is reached and the road branches. From there onwards, the two different road boundaries will be followed until another branching occurs etc. The path finding algorithm will stop after either one of two threshold values is reached. These values are either reaching the maximum distance of the path from our current location (set to 1000 meters in this implementation) or reaching the maximum number of branch levels of the path (set to two). These values can be dynamically updated to adjust for speed, for example, to allow for a variable window of future events.

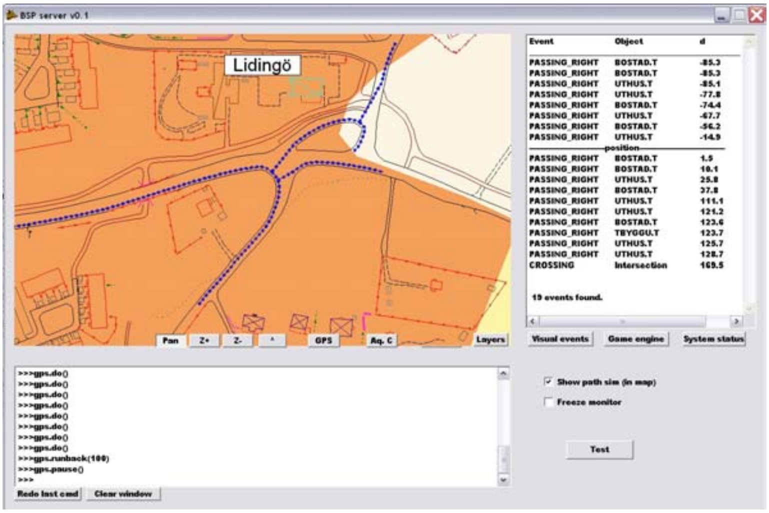

Fig. 4. Server functionality for path prediction (left) and list of generated journey events (right)

The test implementation only provides data on the path to the first branch to the game event manager. However, the path prediction continuously occurs up to two branch levels ahead in the GIS module. This allows for quicker completion of upcoming requested data to the game event manager. The algorithm depends on reliable GIS data. Failures will occur e.g. if a gap occurs in the road side boundaries. To reduce the effects of such problems, the path prediction algorithm will restart and begin a new search for a suitable road on encountering such an error. In the meantime, the system continues running non-location based events.

Extraction of visually available information: GIS data contains point objects, line objects and area objects, which represents houses, roads, forests, elevation curves boundaries and so on. The different objects are sorted into different map layers, i.e. files in the data base and marked with different categories of the map supplier's choice. In order to provide an experience where the visual geography has meaning in the narrative, as seen by the player, we need to select the objects available in the map layers that could possibly be seen from the road. Abstract objects, e.g. political borders, are not considered as useful. However, some of visually available objects are only implicitly available in the map information. We then extract such objects e.g. intersections, by use of algorithms customized for that specific object.

The process of selecting layers and processing map information for implicit information is dependent on categories and layering provided by the map manufacturer. In this prototype we use map data from two different manufactures. Altogether we use about 50 different categories of objects and only one algorithm for implicit information extraction.

Mapping objects to journey experience: The next step is to combine predicted paths, with the extracted geographical objects, to generate what we define as a journey event list. A journey event is a prediction of an important visual event occurring along the path of the journey involving a geographical object. In the current prototype we have so far define three different events i.e. passing right, passing left and crossing. Passing right is defined as the closest point where the distance to the object goes from decreasing to increasing and the object is to the right of the car. Passing left is the same only with the object left of the car. Crossing is the point where the predicted path intersects with a map object.

To further distinguish the visibility of the objects we also predict the distance and direction to it, as well as the frequency in which they appear. The assumption is that unique objects close by in the middle of your field of view are more visually important than others.

Game event manager

The game event manager, i.e. the game engine, handles the progression of the game and makes sure different parts of the story are triggered to ensure a meaningful unfolding as well as an interesting pacing of the narrative. The game event manager first receives a list of roadside objects from the GIS module and then asks each story script to rate their current priority to execute according to their perspective of the world. It receives each story scripts internal rating values, rated from 0-100%, and filters out the story script with the highest rate at that moment in time. If the rating is high enough it triggers the story script to proceed with its plot.

The game event manager additionally makes its own rating based on a holistic perspective of the world. It is important that story scripts are executed in a proper order in relation to each other, two murder story scripts should for example not be triggered right after each other. Further, in order to ensure a rich user experience it is important that the story events are triggered at a satisfying pace. In this way the rating value at which the story scripts are triggered decreases by time.

Initial performance test

We have conducted an initial performance test on the island of Lidingö to get feedback on the technical performance. The test was conducted on a ten kilometer long route, which was predetermined by a person unfamiliar with the project. The route planner was asked to draw a route on a map of Lidingö (see figure 5). We then traveled along route once at the speed limit.

We started at the west point of the track, and video recorded the journey. We traveled for 1 minute and 16 seconds at a speed of around 45 km/h, during which the server predicted the path and generated lists of geographical events, before the computer crashed. We returned to the starting point and traveled again for 1 minute and 24 seconds when it happened again. We returned half way back and traveled for another 53 seconds before another failure. The three crashes appeared very close to each other and therefore it is likely that there were problems with the path prediction algorithm or map data (see section on path prediction). The test continued onwards and the system ran smoothly for 7 minutes and 25 seconds before it stopped again. No game event was triggered during that time, since no relevant geographical objects were listed. The areas traveled trough were urban areas which do not have the geographical features which match with the two available test scripts.

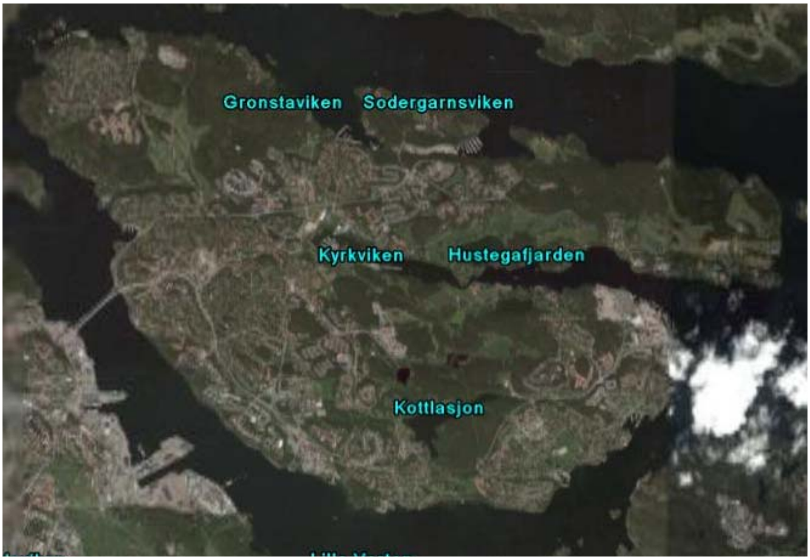

Fig. 5. The test path covering around 10 kilometres

The application was restarted and ran for another 4 minutes and 3 seconds. During that sequence, several game events occurred:

0’00	Restart of application
0’ 57 – 1’ 11	Sound - Wolves howling Interaction - Directional micro phone directed out on the right whereby the sound level increases.
1’ 08	Screen – A text presenting two options appear on the screen. Interaction - Select to send message to Helena
2’ 06	Sound - Incoming phone call Interaction - Answer call by pressing the green phone icon.
2’ 10 – 2’ 19	Sound - Female voice says “How strange. I didn’t thought we had wolves in Lidingö. I ask around to see if anyone heard anything.”
2’ 20 – 2’ 22	Sound - Wolves howling
2’ 23	Interaction - Toggling through screen which provide notes as to what has happened so far.
3’ 16	Sound - Incoming phone call Interaction - Answer call by pressing the green phone icon.

3' 18 – 3' 33	Sound – Male voice says "Benjamin, what is all this nonsense about wolves. I am sure it is just a large dog. You must be mistaken." Wolves howling
4 ' 03	System failure

Fig. 6. List of events during test

Directly after leaving the urban area, we encountered woods. The application then successfully triggered the wolf script (see figure 6), and generated a howling sound that was located by the system in the wooded area. When the player chose to use the directional microphone and succeeded in directing in towards the location of the wolf sound, it triggered a chain of events. First, the game provided the player with an alternative to send a message to Helena, the player's partner back at base. The choices are to tell Helena about the wolves or ignore the sound. Helena then returned with a phone call taking the players concern serious. However, the police chief called Ulf, made a call shortly after criticising the players' judgment, before the application halted.

Thus, the application worked smoothly supporting interaction both through the movements of the vehicle, and the interaction with the player. It managed to predict the paths ahead of the vehicle and extract information, such as the existence of wooded areas. It then provided the game event manager with the geographical event lists, which triggered the wolf script. Furthermore, it responded to the user input when the player used the directional microphone as well as when making selections on the screen.

When the application was restarted, another occasion of the wolf script was quickly generated since we were now surrounded by wood lands. This time, we ignored investigating the wolf sounds with the directional microphone. This triggered another direction in the narrative, where the field agents connect to the player over the walkie-talkie to request further investigation. Again, the application worked according to expectations.

Summing up, the application manages to generate a story, which combines references to the geographical context with user interaction. However, the technical performance of the application needs to be developed further to make it more stable and to make the story a richer experience.

Discussion

We return to discuss the characteristics of believable environments and how our implementation meets these requirements, as well as how the actual prototype performed in the initial test.

Everyday meaning: We suggest that the referenced locational object should partly preserve an everyday meaning to the player. First, this implies that the GIS module should list reference objects which are easily recognised by the player. The GIS data available provides many classes of objects such as houses, fences, antennas, and woods. These classes of objects have a meaning, which is understood by a player. Additionally, the same objects must also have meaning as part of a narrative in the game. Here, the implementation shows the prototype managed to find GIS data in the vicinity and link that to stories, which were presented to the user. Furthermore, instead of just describing the objects with their geographical coordinates, we provided a framework in which the objects were defined in a user centric approach, by generating journey events. This adds to the perspective of objects as having everyday meaning, i.e. objects as encountered during travels.

Scalability: A believable narrative environment should surround the location of the player. It follows that the data should be available along the whole road network and have enough density to provide story experience almost anywhere. The implementation covers an area of around 35 square kilometres (around 41 000 inhabitants), which is per se much larger than other similar narrative environments (see related works). The prototype utilizes two different forms of GIS data. The data base provided for by the City of Council is used for path prediction, whereas the national GIS database from Lantmäteriet is used to generate additional geographical objects. A critical feature to ensure scalability is to link the story to geographical objects in databases with vast coverage. Since the data from Lantmäteriet, which we used for linking the story to the locations, is available for the whole of Sweden it further ensures scalability beyond the island of Lidingö, i.e. our test area.

The level of detail in available GIS data is more than enough to ensure provision of narratives. The maps supplied by the City Council provide rich details such as fences; staircases, and form and size of most houses. However their data base was rejected in favour of the more meager GIS data from Lantmäteriet. The additional detail was not considered relevant for the test story, and would “slow the computer”.

Finally, it is important to consider whether the objects chosen for the implementation fits with other types of landscapes. Lidingö consists of both rural areas as well as urban areas. Although the game is implemented for a large geographical area, it still needs to be understood whether this applies to other geographical areas. Here, a specific challenge is to provide stories where the geographical objects vary little over a long period such as when travelling through vast woodlands.

Sequential storytelling: We argue the importance of fitting the story to the journey experience, rather than fitting stories to individual locations, to create believable environments. First, it follows that the implemented prototype must present a story which relates to the travelled path and the stories being told. The prototype succeeded in generating such story segments which both made sense in their temporal order as well as their referencing to locations in the story. Second, interactive narratives are generally considered less persuasive than ordinary stories since user control diminishes authors control over the way in which the story unfolds. In our case, user interaction will create a story which should be interactive with players' choices, as well as with their movements through the road network. It is possible that a single story line would not provide sufficient interaction to provide a good experience. The event manager has to hold the progression of the story until a requested geographical object emerges, which can break the experience of the story linkage to the environment. Therefore we have implemented a solution, which provides for several related linear story lines which run in parallel. In the test implementation, only two scripts were implemented. The solution consists of longer story with many related threads, as well as a shorter story with a few threads. Finally, we provide individual sound effects which further add to the feeling of a believable environment. The combination of several stories allows us to pace the storytelling, with the journey as it unfolds. At present, cannot predict the journey more than around 1000 meters ahead. This can mean that some stories require events or objects that take a long time to appear. To avoid the player getting bored whilst waiting for these objects, the availability of other stories is then used to enrich the landscape with additional interesting content. We have also implemented a choice to progress the story by using global content, i.e. story elements which do not reference specific geographical content, such as that occurring in the test.

The implemented game draws on the crime story genre, where the geography is used to place clues and situate action events. Thus, the genre is chosen to generate a believable environment. However, it is still an open question as to how this environment could be believable in other genres.

Blended attention: We suggest that the player should mix the interaction with the devices and with the physical surrounding to generate a coherent experience. The implemented user interaction is audio centric, where most of game and narrative features are presented as sounds. Additional interaction through movements is integrated with audio in the form of a directional microphone. The intention has been to allow as much visual focus as possible on the landscape. However, for practical reasons the response to the speech is designed as a selection of options from a list display on the screen, rather than as speech recognition. The latter was, at this stage, considered too technically demanding.

The audio centric approach differs from a visual design approach based on e.g. see-through displays. The latter are considered lacking in precision which generates nausea and low user experiences (Brunnberg & Juhlin, 2006). Audio interaction, on the other hand, is generally less applicable for precise positioning. Humans find it harder to orient the location of a sound source than orienting it visually. In this case, we expect tolerance of the players to limitations in precision in positioning of sound effects. Further, we suggest that audio encourages the player to shift their attention to the surrounding environment, even though the game does not change the environment as seen from the car. Sounds are intended to evoke imagination as to what is happening just behind a bush; inside a house or around the corner.

Finally, the combination of vagueness and evocation is well suited to a game generated from GIS data. Even though the data is a rich source for narration, it cannot be compared with the possibilities afforded if the author gets to visit the geographic location. Here, an ambient and vague form of audio interaction could be useful since the level of detail, and understanding of the location, is not as determined as in situated game design.

Conclusion

We argue that an important step for the development of pervasive games is both to design for vast environments as well as include narrative based content. Pervasive games, designed for vast areas, would then evolve from available chasing tasks and performance type of use contexts. The area of interactive storytelling provides new resources for such an extension, and introduces the concept of "believable environments" as a topic for research. If the focus is on utilizing a section of the landscape, as seen from the back seat of a car when travelling, we suggest a focus on four design characteristics. These are: the references to geographical objects with everyday meaning; scalability over vast areas; sequential story telling and finally support for blended focus of attention. The paper further contributes with a suggested implementation, which introduces concepts for linking a GIS module to a narrative engine. Thus, the ambition has been to add features to available engines rather than developing them according to dominant research directions within interactive story telling research. It is possible to conclude from the initial performance test that our concept is technically viable. The application provides an innovative and vivid experience. However, there are still issues in making the application stable. Furthermore, the content needs to be expanded to provide for an engaging experience that complements journeys in the back seat. Finally, an important step is to evaluate how players experience being field agent managers tracking and uncovering werewolves around their family car.

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Chapter 13

Movement and spatial interaction - Inclusion of journey experiences in game play[6]

Abstract

This paper discuss the implication of movement when designing for spatial interaction in mobile use contexts We present a user evaluation of "Backseat Playground", a pervasive game prototype that enables children traveling in a vehicle to enjoy a narrated experience where game-play combines with the view from the road. The evaluation provides feedback on how the users interacted with the physical landscape during swift movement. It reveals that users' physical movement through the landscape has consequences both for the way they practically interact with it, as well as the way they experience the environment. Based on the study we argue that movement is an important design parameter when designing applications for mobile spatial interaction.

Introduction

In recent years there has been an increased interest in mobile spatial interaction in mobile use contexts. A number of applications have been suggested for pedestrians such as support for navigation (Strachan et al, 2005; Warren et al, 2005) as well as location dependent games (Bell et al, 2006; Flintham et al, 2003, Jonsson et al, 2006), which make users physical movement an emerging issue. Here we will consider mobile spatial interaction for passengers traveling in vehicles, which brings forth a use context where the users move in higher speeds. This makes their encounters very brief, and gives them very limited control of their motion. The purpose of this research is to investigate how users'

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[6] Brunnberg, L., Gustafsson, A., Juhlin, O. Movement and spatial interaction - Inclusion of journey experiences in game play (to be submitted).

movements, i.e. speed and direction, affect the practicalities and experiences of mobile spatial interaction within a game context.

We present an evaluation of a location based game, called the “Backseat Playground” (Gustafsson et al, 2006). It runs on a platform consisting of a PDA, a gyro and a GPS receiver, as well as a server running on a lap top that connects to the game device over WiFi. The application provides audio centric interaction, which includes a number of in-game features such as a telephone; a walkie-talkie interaction and a directional microphone to investigate the soundscape surrounding the car. The player acts as a manager for field agents. The tools are utilized to unfold a crime story with super-natural twists, where the actual location of the car is of importance. The game characters reference geographical objects in the vicinity, and the player investigates what is happening with the directional microphone and interacts with other characters over the phone or the walkie-talkie.

Game play for journeys is motivated by the size of this social activity. Transportation is an important part of most people’s mobile life, and an important use context for mobile spatial interaction applications. Statistic shows that people in the U.S., in average spent twenty-four minutes for commuting 2001 each day, and those who used public transportation had to add another sixteen minutes (Hu & Reuscher , 2004). People over sixty-five years old spent as much as an hour per day in their vehicles, and children younger than five years spends three quarters of an hour a day in a vehicle. In U.K. passengers’ conducts in average 228 trips in cars, adding up approximately 82 hours of traveling per person and year (DFT, 2005). Children younger than five years old travel in a vehicle as much as 45 minutes per day. A passenger has to sit still for some time. Since, they are not in direct control of the vehicles physical movements it is possible to enjoy the journey by looking out through the windows, read, or daydream. However, this period of physical inactivity is sometimes considered as boring (Mackett, 2001), which makes transit a common use context for mobile games (Andersen 2002). Thus, passengering is a large social activity, which already includes abundant use of mobile applications.

We argue that the choice of passengering as use contexts brings forth users’ physical movement, i.e. their speed and direction, as an important characteristic, with consequences for how context dependent applications, such as games, should be designed. More specifically, we need to adapt applications to the users' inability to control their movement vis-à-vis the geographical arrangements. Informed by architects interested in road side architecture, such as Donald Appleyard (Appleyard et al, 1964), Kevin Lynch (Lynch & Southworth, 1974) and Robert Venturi (Venturi et al, 1977), we argue that the physical movement of the passengers affect their focus of attention on the surrounding geographical arrangements; it affect the way in which passengers interpret and experience local objects, and it affects the temporal unfolding of the surrounding.

The paper is structured as follows. First we present related research and a theoretical background informed by architectural research. Then we provide an analysis of a user evaluation study, followed by a section discussing the results.

Related works

Our research is related to the areas of mobile spatial interaction as well as location based pervasive games. The research area of mobile spatial interaction explores how mobile applications can support interaction with users' immediate surroundings (Fröhlich et al, 2007). Existing research focuses on pedestrians' problems in interacting with small screens, in a mobile use context. There is a need for alternative presentation and interaction metaphors (Sambat et al, 2007). Several projects suggest audio as a way to present digital content. Ontrack (Warren et al, 2005) and gpsTunes (Strachan et al, 2005) adapts music listening to guide a pedestrian to a desired physical location. The audio has no other relation to the surrounding landscape than providing orientation cues. Bederson (Bederson, 1995) suggests that audio augmented reality, could enable automated tour guides in museums. Alternative interaction techniques, such as pointing, touching and gesturing, has also been investigated. The Point-to-Discover project (Fröhlich et al, 2007) explores the concept of pointing by means of a combination of GPS, digital compass and tilt sensors. Other technical solutions include pattern recognition techniques on camera phones (Yeh et al, 2005; Nokia, 2007). The user could for example point the device towards a film poster and consequently receive information about the film from the Internet. These solutions, either depends upon the user's possibility to walk up to and stop at a desired position in relation to an object, or is conceived for the pedestrian use context.

There exist a wide range of projects which explore the prospect of location–based pervasive games (Bell et al, 2006; Flintham, 2003; Jonsson et al, 2006), with the purpose to engulf the player in a fictive experience including the immediate physical surrounding through mobile technology. “Feeding Yoshi” (Bell et al, 2006), makes use of wireless networks around a city to create a game-environment. Secured wireless networks represent virtual creatures called Yoshi’s. The player’s mission is to locate and feed them by growing and retrieving fruits from plantations, represented by unsecured wireless networks. This game is played via the interface of a mobile device using traditional graphical user interfaces, with buttons and stylus as interaction mechanisms. “Can you see me now?” (Flintham et al, 2003) is a mixed reality chasing game where online participants compete with mobile participants on the street. It is also based on a traditional graphical user interfaces, but the participants can also collaborate by communicating via a real-time audio channel while moving through the city streets. “Prosopopeia” (Jonsson et al, 2006) is a live action role play that merges game play with ordinary life and where both the people and the objects of the real world have a direct role in the unfolding narrative. All these games are designed for pedestrian use in urban areas. However, the evaluation of Feeding Yoshi showed that it was also played in cars, buses, trams and trains, and even when bicycling. The extensive movement made it possible to discover new hotspots, but the speed also made it difficult to connect to the encountered hotspots. Accordingly, the player had to stop or slow down when they were near useful access points to pick fruit or feed Yoshis.

The research discussed above deals with pedestrian use contexts, and hence, it account for slow movement in physical space. However, it does not explicitly explore the implications of velocity and direction as a design parameter when designing applications for mobile spatial interaction, except as a matter for spatial navigation. Furthermore, the pedestrian situation differs in general from the passengering in several ways. Passengers are not involved in maneuvering their body or their vehicle, whereas the pedestrian has to be rather pre-occupied with the activity of walking. Pedestrians’ interaction with a mobile device often becomes supplementary to the task of handling the physical movement. It follows that passengers are not able to control their movement, either as a way to spatially interact with their mobile device or with the geographical environment. Finally, since they often travel with higher speed than pedestrians their time to engage with geographical objects is much more limited.

Backseat Gaming (Brunnberg & Juhlin, 2003) and Road Rager (Brunnberg & Juhlin, 2006) are two game prototypes developed for passengers. Backseat Gaming focuses on the possibility of integrating roadside objects within the gaming experience. The “Road Rager” focus on the interaction with other passengers, in oncoming vehicles, as part of the game-play. Even though speed is an essential feature in both games, the conducted research does not specifically address how movement affects spatial interaction.

Motion and journey experience

In this section we discuss passengers’ experience of moving through physical space and how a passenger relates to the passing landscape. In general, the way in which we interact with environments has been a key topic within the area of Computer Human Interaction, although movement has never been a key topic. The well cited paper “Replaceing space” (Harrison & Dourish, 2006) have been influential in the discussion on how to design support for interaction in virtual environments. It establishes a distinction between the concepts of space and place. Space describes geographical arrangements that might “structure, constrain and enable certain forms of movement and interaction” (Dourish, 2006). Thus, they recognize movements as something affected by geography. In collaboration, geographical arrangements constrain such things as relational orientation, possible actions which require proximity, or presence (Harrison & Dourish, 2006). Place refers to the social meaning of an environment, acquired by conventions, roles and use. In later paper (Dourish, 2006), Dourish argues that the distinction is too rudimentary. However, we argue the concepts are still useful as starting point for discussions of the design of pervasive applications, where the environment includes physical objects and landscapes. In this paper we bring the physical movement to the front, arguing that being a passenger brings with it a specific way of orienting to both dimensions of place and space.

Our researched is informed by early studies in architecture on how the journey experience affects design of road side architecture. Donald Appleyard and his colleagues analyzed the “view from the road” in the 1960s (Appleyard et al, 1964). Based on their studies we argue that fundamental for the passenger experience is the perception of the geographical arrangements in the way we focus our attention on the surrounding landscape given the restricted time; the way we interpret individual geographical objects and the way we connect places into a sequential experience. They argued that a passenger's visual focus of attention is affected by the speed of the vehicle which makes each object appear during very short time. Motion, as well as spatial geographical arrangements, structures certain forms of interaction. The direction of the gaze is likely to change with the speed of the vehicle. At high speed the visual attention tends to be directed forward, while a slower speed allows a more general scene where the viewer is likely to pay more attention out on the sides. The shape of the road itself might contribute to directing the attention of the viewer. A curvy road would for example direct the viewer's attention in an outward angle. A viewer is more likely to attend to near objects in the immediate environment and apparent "moving" objects rather than distant stable ones.

Kevin Lynch and colleagues discussed the ways in which passengers' movement along the road affects the experience of individual geographic objects has been discussed by Lynch et al (Lynch & Southworth, 1974). When people were walking through the city they had time to interpret what they saw, and could e.g. understand how the road side architecture witnessed of various interesting social activities. However, vehicle passengers have not the same possibilities, given their much higher speed. We term the passing understanding of both details and local meaning to a cursory experience. The design of modern roads and road side architectures, such as a Strip running through a US city, handle the growth in people moving through cities in their vehicles, but the road side architecture has not been adapted to visitors' higher speed. The same small signs and forms of houses, which the pedestrian could read, is today out of reach for a passenger passing in 70 kilometers per hour. Lynch et al promoted an adaptation of road side architecture, to make the local context transparent for the highly mobile modern visitors. The architect Robert Venturi agreed on the effect of high speed, but instead saw it as an advantage (Venturi et al, 1977). It provides an opportunity to engulf the traveler in a new role by heightening the symbolism of surrounding roadside objects e.g. the signs in Las Vegas reminding of Roman culture. Heightened symbolism and ornaments in signs and architecture can be used to enable the imaginary and appeal to the tastes and values of "common" people. The speed of the vehicles erases the ordinary local meaning of individual geographical objects, which is then transformed into something completely different through the large scale road side architecture.

Finally, Appleyard et al (1964) argue that since the traveler moves in physical space, the view changes from one moment to the other generating various sequential experiences. The experience is combined by a series of objects, which might provide a dramatic experience where the arrangement or type of object abruptly changes, or a more stable and soothing experience where a homogeneous arrangement of objects gently move against a large background or slowly pass in far distance. A uniform and predictable space often contributes to a sense of fatigue and boredom during a journey, while spatial change and contrast in the surrounding landscape often add to a gratifying experience. The sequence of objects depends on how the passenger moves through the road network. A road can normally be followed in two directions. Traveling along the road in one direction contribute to different order and visibility of objects than if it was followed in the opposite direction.

Although the architects provided detailed and empirical studies of the journey experience, we need to recognize that they studied passive viewers of the passing landscape. With our suggested spatial interaction in a game context, the role of the passenger will be much more active, which might change their interaction and their experiences.

Designing backseat playground

In this section we present the prototype and an intended use scenario. Furthermore, we describe how the implementation is influenced by the theoretical perspectives on movement outlined above.

The prototype game

Backseat playground is implemented as an interactive narrative occurring along the road you travel. The front end of the prototype consists of a game device in the shape of a directional microphone (fig. 1) and a pair of headphones. The directions microphone metaphor is used in order to superimposing an aural landscape on to the outside view. For this task is contains computer hardware in the form of a Pocket PC and an advanced sensor module containing magnetometers, accelerometers and gyros capable of sensing users movement of the device. The game device provides a visual interface through the display of the Pocket PC.

This display is used to incorporates a number of virtual tools in the form of a walkie-talkie (fig. 2) and a phone. The phone and walkie-talkie provides communication with in-game characters with is one the primary ways for the player to affect the storyline.

Fig. 1. The game device

Fig. 2. The walkie-talkie

The backend consists of a Bluetooth GPS receiver, a laptop (hosting the game server) and a local wireless LAN. The wireless LAN is used to connect the client (the game device) with the server (the laptop). The Bluetooth GPS can be linked to either the Pocket PC or the Laptop. Incoming position data will be relayed throughout the system. The server contains commonly available digital maps, game scripts, sound effects, several voice libraries (for speech synthesis of different characters) as well as story and map engines (see (Gustafsson, 2006)).

All equipment except the headphones and game device is hidden away inside the car before game start. During play a soundscape is automatically generated as the player moves through the landscape using the information provided by the maps and the user's movement given by the GPS. This is done by fist filtering the maps for suitable information which is then translated in to events occurring along the road. The events are then provided to the game scripts implementing the narrative. The story within which this narrative evolves is basically a crime story with a supernatural twist where you play a field agent manager assigned to solve what initially looks like a simple robbery.

A game scenario

Dave is sitting the backseat of his parent's car on the way to visit relatives in a nearby city. The car is moving along a country side road. He looks at a field, a barn and a power line appearing in the distance. His peaceful observation of the surroundings is suddenly interrupted by a crackling sound. He turns his attention away from the scenery outside and on to the walkie-talkie in his hand. A man's voice appears over the radio: “Agent Bravo to agent Alfa. I just saw you car passing bye. We are here at the other side of the golf course searching for the robbers. Over!” He looks up and indeed sees a golf course on the field just behind the barn. He decides to pull out his directional surveillance microphone and starts sweeping the surrounding landscape for suspicious activities. From the forest on the other side of the golf course a couple of birds can be heard among the trees. Everything else seems to be dead quiet. The sun is disappearing behind the tree line and the landscape is beginning to fill with long dark shadows. Then suddenly the deafening sound of a gunshot pierces the quietness. He quickly reaches for the walkie-talkie in order to contact the nearby team of agents over the radio.

As the agents engage in a search to find out the location of the shooting, David continues to use his surveillance microphone. From one of the buildings on his right side some suspicions voices can be heard. He keeps the device pointed at the building in hope to catch some of the conversation going on. Finally he picks out a few words, something about ammunition. He decides to call in the team. He contacts the agent and tells them to be careful since the suspect’s seems to be armed. Moments later he gets a report back over the phone. The agents unfortunately, where a little bit too careful and by the time the building was stormed whoever was in there, had escaped. A gruesome discovery however was made. Left in the building on the floor was the dead body of a man.

Accounting for passenger movements

The game is designed to account players movements through the landscape. First, it means that the interaction with the mobile devices must be adapted to the interaction with the landscape where objects pass very quickly outside the vehicle. The passengers have very limited means for controlling their speed and direction in order to adapt it to potential needs for interaction with a location based service. Since we want to enable a combination of the journey experience and the game experience it requests that the player gets time to visually focus on the landscape. The suggested design is largely sound based since previous research has shown that even minimal graphical interaction, diverge passengers’ attention away from the outside environment (Brunnberg & Juhlin, 2006). It gives the player the ability to listen to fictive activities played out inside houses and other places in the surrounding. More specifically we refer to interaction where players visually experience the surrounding landscape and at the same time experience it through digital media, as blended interaction.

Second, the design should also alter the cursory experience. We argue that the application should make the geographical objects transparent. With transparency we mean the communication of local meaning of geographical objects over distance and during a very short interaction span. Transparency is achieved by utilizing the commonly known classification schemes of public map makers as it is expressed in digital maps. A map database contains spatial information about physical objects and features within a defined geographical area. It include ready-made social encodings of objects such as e.g. houses, public buildings, mansions, churches, sports grounds, golf courses, ancient landmarks, woods, wetlands, lakes, fields as well as altitudes. The data enables us to present the road side in new meaningful terms, with the intention to overcome some of the loss of detail and local meaning due to the speed. In particular, the available data covers an area of around 35 square kilometers with around 41 000 inhabitants. But the geographical area could be expanded with additional data from the map data provider. Furthermore, we argue that meanings could be transformed i.e. referenced to as geographical structures but with associated fictitious content. We suggest that games designed are favored by a combination of those approaches, which we refer to as a twist of the cursory experience. It is made through juxtaposing them with fictitious stories, sounds etc.

Third, the experience of an individual geographical object is influenced by passengers' previous encounters. An experience of a single object is influenced by where they have been and what was experience on those locations. The physical movement makes the interpretation of an object a part of a sequential experience. Accordingly, the game design must also adapt. It should fit into a series of experiences, rather than just to a single location. In this way the path of the journey in combination with the movement of the vehicle will form a sequential story rather than a random anthology. Consequently, a challenge resist in generating a narrative which fit with the order of the upcoming geographical objects. In the implemented game, the engine holds the narrative until it finds a geographic object it can use. These objects could be of various kinds, e.g. the golf course in the example above depending on the story. Furthermore, the speed of the movement affect the time it takes to move from one game location to another. Thus, the speed has consequences for the pacing of the experience. In all, the game engine has to hold the progression of the narrative until a requested geographical object emerges, which can unleash a sequential event. As a player's intended route is unknown for the game, the appearances of physical objects are highly arbitrary and a specific object might take time to appear. It is therefore possible that a single story line, with specific local objects, would not provide sufficient interaction for a good experience.

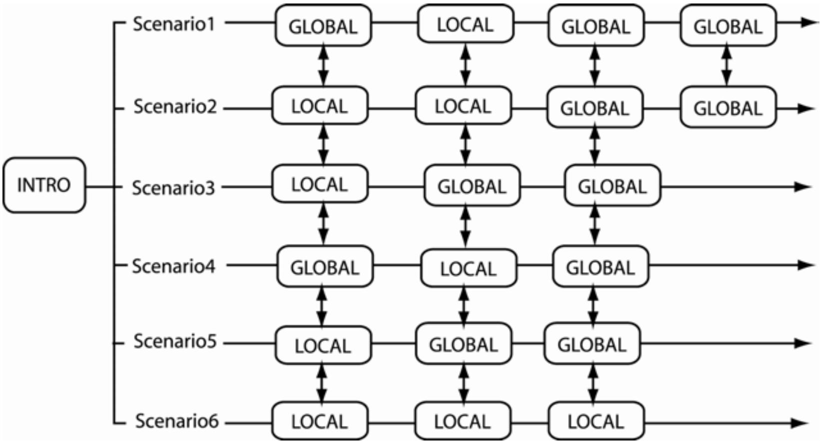

Fig. 3. Overview of game scripts

Thus, the prototype is implemented with six related episodes which run in parallel, and which could refer to various types of geographical objects depending on availability (see figure 3). Each episode includes a set of events that progress the narrative. In a local event the narrative is linked to a physical object or place currently within sight for the player. Each local event accepts a different set of objects to execute, which change based on elapsed time. When the game starts, a local event might only accept an infrequent object, such as a church. If no church appears for a set period of time it might also accept a common object, such as for example ordinary private houses. We have also added game events with no geographical reference to ensure that the player is provided with an enjoyable pacing, although no possible geographical objects come up.

Method and setting

The trial was carried out on a 25 kilometer long test round on the island of Lidingö in Stockholm. Each test consisted of about 30 min playing time followed by interviews and questionnaires. The trial was carried out on a total of ten players, of with three where girls and seven boys. During each of the five test runs the two players took turn in holding the game device. Each test run was carried out with two participants at the time enabling us to use the interaction between players to gain further insight in how the game was perceived and played (Höök et al, 2003). A combination of methodological techniques was applied since we were interested in both the players perceived experience, as well as what their actual physical interaction with the game and surrounding landscape. First, two or three video cameras were used to capture the players' physical interaction with the game. A video analyze tool was created in Director, which simultaneous playback of the different feeds together with a system log showing all the different game events occurring. Second, a loosely structured interview was performed in conjunction with the test trial, with a method somewhat similar to the "Mission from Mars (MfM)"-method (Dindler et al, 2005). In MfM the interviewer take on a fictional role to persuade the children to give more detailed answers. In our case, the interviewer, who where not present during the test run, took on the role as an in-game character of a local news reporter from Lidingö news paper. He asked the participants questions as if they were the agents they played in the game. Finally, the test participants where handed a questionnaire containing questions to be answered in a scale from 1-7, starting from disagreement to strong agreement. The questionnaire has been analyzed, and the results are presented with mean values ($\bar{x}$) and standard deviations (σ). The questionnaire provided a way to get generalized data. It also provided us with a way to spot individual differences in the participants' experience that might be hidden by the participants playing and being interviewed in pairs. All interviews where recorded and later transcribed. The video material was viewed several times in pursuit of specific interaction styles. Where such where encountered the material was transcribed and further analyzed.

Analysis

Focus of attention

In this section we will discuss the ways in which the players interact with the devices and the landscape, as well as how they focus their attention.

Table 1. Results from questionnaire on focus and interaction

Nr	Question	$\bar{x}$	σ
1	One easily understands what house or thing different sounds originate from?	5,10	2,54
2	When you play you mostly look at the screen of the device!	4,00	2,25
3	When you play you mostly look out through the window of the car!	4,44	3,03
4	It was easy to play the game and at the same time see all the things outside the window!	4,90	1,43

The questionnaire (table 1) provides some insights on a general level. It reveals that directional sound could be located easily by most players (1). Only two of the players marked this as difficult. They scored equally on the second question concerning whether they visually favored the screen or the device They also felt that it was possible to both play the game and keep track of objects outside. Overall, the questionnaire gives the impression that they had a balanced interaction and focus between the digital devices and the swiftly passing environment. Although this information indicates that our approach has been somewhat successful, there is not much in the questionnaire that reveals the details in which they managed to focus both on game and environment. The video recordings give more insights into these activities. We have looked through all the video feeds a number of times. Here we will present examples of reoccurring player techniques and ways of focusing their attention when they interact with a swiftly passing landscape. We are specifically interested in the use of the directional microphone, since it requires most exact interaction with the geography. The person currently in possession of the game device will be referred to as the player. The other person will be referred to as the co-player.

Vignette 1. Simultaneous orientation: The first excerpt show an interaction technique where the player keeps the gaze and the device aligned while playing.

Fig. 4. Sophia sweeps the device to the left as she looks in the same direction

Table 2. Excerpt showing simultaneous orientation

Time	*Road context*	*Hand movements*	*Visual focus*	*Expressions*
01:34	Driving along the road.	Holding the device facing forward.	Looking at the device.	
01:36		Sweeps the device to the left, holding it high up.	Continually locking in the direction of the device.	
01:37		Stopping far left and sweeping back right.	Still looking in the direction of the device.	
01:41		Stopping as the device points towards the co-player.	Look at the co-player.	Giggles together with co-player.

In table 2, Sophia holds the device facing forward. She initiates a careful sweep to the left, while looking in the direction of the device (01.26). She stops the motion and starts sweeping back right, when the device is aligned with her shoulder. As Sophia reaches the right shoulder she is aiming straight for her co-player Olivia (01.45). This causes both players to laugh. The device is hold in level with her face during the entire period during the whole period. Her gaze and the direction of her pointing is constantly aligned. We refer to this initial interaction method as simultaneous orientation (Trevisan et al, 2004). Furthermore, the player in this example holds the device high in order to avoid obstruction by the steel frame of the vehicle. This is not necessary since occlusion is not implemented in the directional microphone. Although at this stage the player does not know this yet. Sophia has just begun to familiarize herself with the device, and seems to accept our suggested metaphor of a directional microphone.

Table 3. Excerpt showing aural orientation

Time	*System*	*Road*	*Hand*	*Visual focus*
04:37	None	Driving along the road	Sweeps device to the right.	Head and gaze forward.
04:39	Mans voice		Stops the device at 3 o clock	
04:41				Turns head and gaze towards direction of device.
04:42		Car slows down.		Leans down to take a better look at house outside on the right.

Vignette 2. Aural orientation: The next excerpt displays how the player search the landscape by first moving the device to find an interesting sound and only thereafter move the gaze to look at the object.


Fig. 5. Player listening to a sound (04:39) **Fig. 6.** Player looking for the origin of the sound (04:41)

In table 3, Daniel scans the surroundings for sounds by moving the directional microphone in a sweeping motion from left to right (04.37) (see figure 5). He halts the device and listens shortly when an interesting sound appears (04.41). He turn his gaze, that until now has been directed passively straight forward, towards the direction of the sound (see figure 6). As the car slows down due to a traffic situation, (04.42) Daniel leans forward and take an additional look at the building in the direction of the game device. In this case, the player relies almost entirely on the aural cues from the system in order to find game events. Alignment of visual attention and hand movement occurs only later. We refer to this technique as aural orientation. Furthermore, we note that he leans forward to get a better view when the car slows down. Thus, movement and speed clearly changes conditions for the player's focus of attention.

Vignette 3. Visual orientation: An alternative form of focus and interaction is also prevalent in the videos. The player sees the object first and then uses the game device to examine the object. Here, the players investigation is initialised by visual rather than aural cues. We label this interaction form visual orientation.

Vignette 4. Skewed orientation: In this example the pointing and looking are actively conducted in parallel.

In table 4, Daniel moves the device from side to side in the car (14.13). He stops briefly when he detects interesting sounds (14.17). Occasionally he looks in the direction of the microphone to establish the origin of a sound. As he scans with the device his eyes searches the surroundings continuously in all directions. When he spots something interesting he sometimes interrupt the sweeping motion with the device and aim directly towards the object. The visual orientation and the aural orientation are now used at the same time. By scanning one side with the device and one with the eyes the player manages to cover more grounds compared to when using solely one of these strategies. It differs from all discussed techniques in the more limited time when gesture and gaze are aligned. The variation of the temporality of alignment has not been quantified, but is empirically observable in the video data.

Table 4. Excerpt showing skewed orientation

Time	*System*	*Hand movement*	*Visual focus*
14:13		Begin sweeping the device forward	Locking straight forward
14:15		Continuant sweep towards left	
14:16			Locking left
14:17	TV,owl	Holding the device to the left	
14:24			Locking forward left
14:25		Sweeping the device slowly to the right again	

Summing up, the video analysis gives much more detailed insights in how they cope with interaction with a passing landscape, than the questionnaire. We identified four ways in which they combined hand movements and gaze to generate a combined experience. The skewed interaction seems to be the most effective for investigating the landscape.

Interestingly, it is very different from our design intention to favor visual orientation. It differs in the very limited interest on the visual details of what they are listening to. Instead, the interest in attending to the overall visual landscape seems to prevail.

Experience of geographical objects

The questionnaire addressed the players' experience of individual geographical objects (see table 5).

Table 5. Analysis of questionnaire

Nr	Question	$\bar{x}$	σ
5	The locations, where the events take place, seems to be good for those particular activities.	5,60	1,60
6	It felt like the game took place outside the car	5,70	0,50
7	It was easy to see the locations that were investigated by my field agents	3,67	1,44

Question five concerned the conceptual matching of game activities and locations. The players seem to approve of the way we have twisted the meanings of locations e.g. robberies in churches or houses, or howling wolves in woods. Question six indicates that the game design succeeds in merging and therefore altering the view of the road with other activities. However, the game scores less on the following question, which asks more the possibility of precise referencing to geographical objects. Thus, the players buy into the twisted experience, but struggle with the precise transparency of locations. The MfM-interview provides more details on the experiences of passing individual objects. We asked the users whether they identified the origins sounds. Michael and Daniel said that they knew it "to some extent". For example, they linked the sound of a submarine to the surface of the water they were looking at. They linked sounds of a tennis game to a tennis hall. Other players linked the sounds of boats to the view of the sea. Furthermore, they connected various sounds to map objects such as a golf course, an enclosed pasture, a harbor, a forest, houses and a road junction. We know that they had experienced a lot more sounds connected to geographical objects, than those mentioned. Furthermore, the objects they mentioned were comparably large. The prevalence for large geographical object can be explained either by insufficiencies in mapping the digital to the local due to deficiencies in the precision of the gyro, or due to the way the sounds are presented. They could also have failed to actually see the geographical objects since they might have been occluded by other objects in the landscape. But then they would rather recall other geographical objects, than those referred to in the GIS data. It could also be explained by the motion of the user vis-à-vis the object, giving a limited time to identify it and then remember it. Geographical objects such as forests, golf courses and enclosed pastures, give them more time to identify and interact with them.

The interviews reveal another interesting way in which the landscape was experienced. The difficulties in recounting what they have seen make them remember what they have seen incorrectly, such as in the following two interview transcript:

Journalist: Where more precisely? Which church are you talking about?

Michael: Mmmmm, don´t know.

Journalist: What did it look like?

Michael: Like an ordinary church (Daniel: Yes)

Journalist: You actually did see the church?

Michael: No (Daniel: No)

Daniel talks about a church he has seen. He even describes it as "ordinary" and Daniel agrees. Upon further questioning both of them reconsiders and claim that they have not seen the church. Interestingly, the interviews with Steve and Bob reveal a similar confusion as to what they have actually seen:

Steve: We heard the robbers a couple of times talking about 40 000. What was it? 40 000 dollar? (Bob: 40 000 dollar)

Journalist: Okay. Where were they?

Bob: We had just turned into a road by then

Steve: It was in a church, wasn't it? They were in a church.

Bob: Yeah, later on. But we had just turned off.

Journalist: How did you see that it was a church? How do you know that they were in a church? (Bob: First, we heard…)

Journalist: Bob, how do you know that it was a church. I wasn't there you know.

(Bob: I guess you said so.) Steve: How was it? ...this leader, the one who is our main boss said that they had..

Journalist: She said so, but did you see it yourself? (Steve: no)

Journalist: Okay, you didn't see it

Steve: Or wait! I heard it. Yes, I could hear the bells.

They recalled overhearing a conversation between some burglars. When we asked them where it occurred they first referred to a junction, where the car turned, and then to a church. They claim that the conversation could be heard within the church, which was also the location given to the sound effect by the game engine. However, upon further questioning it turns out that the reference was not to the sighting of the church, but that the conversation co-occurred with a sound effect of church bells.

Both those occurrences could be explained by the MfM- method which might evoke not only detailed answers but also fictitious answers. However, we suggest that there is more to it than that. Taken at face value, they all remembered the event as if they had seen the church. The church itself was not made transparent to the passing players. They had actually failed to link visual sightings with sound effects. Possibly it could be explained by movement of the vehicle, which makes it hard to single out specified geographical objects and link them to the game events. However, the cursory experience might also explain why they thought they had seen the church, even if they didn't.

So it works both ways. The interview shows how the systems enabled a twist of the link between the passenger and the road side. They experienced submarines in conjunction with, what was recognized as water both by them and the map data, as well as wolves in what both they and the story engine recognized as forests. Thus, the system recognized objects everyday meaning but twisted it a bit to provide some fantasy. However, the limited time on each location make it hard to single out smaller geographical objects. The interview indicates that the players in many occasions were not able to link the sound to a geographical source we also had some positive feed back. But the cursory experience also enabled the game designer to make them believe they have seen things which they haven't. Interestingly, we also transform the link between their vague understanding of the geographical structures forms and the meaning given to it. The system made them believe that they had seen objects without having been sighted. It was possibly due to the movement of the car given them little option to get a good view of geographical objects.

Sequential storytelling

In this section we will analyze how players experienced the sequentiality in the stories as well as their pacing, as they moved through the landscape.

Table 6. Results from questionnaire on experience of objects

Nr	Question	$\bar{x}$	σ
8	The events are connected.	4,80	0,40
9	It was easy to connect clues and evidence with earlier events.	4,33	1,75
10	The game was sometimes tedious.	4,00	3,75
11	The game lacked content.	4,22	2,44

Sequentiality: We will discuss how the players experienced the order of events. It triggered differently in each session, even though the evaluation took place along the same route. This was due to several reasons. Firstly, the car drove with a slight varied speed during the different test cases. Events that would execute at certain physical locations during one test case were blocked by other events. Secondly, the continuation of the game narrative was also affected by the player's active game play. Thirdly, the sequential structure of the story occasionally turned out differently caused by deficiencies in the technology. In all, the survey revels that all test subjects gave an average or better on the question if they thought the different events stuck together during the game session (8, 9), even though the game never came to an ending before the test session was finished. However, the video recordings and the interviews give more details.

We will in the following discuss the "dead body" scenario, which is a sequence including two geographical events (see chapter 4.2 for a detailed account). The two connected incidents were triggered during all test sessions, although taking place at various locations. The interviews reveal that the players in four out of five cars perceived these two events as part of the same sequence. That is, they linked the gunshot heard during the first event with the dead body found in the continuous event. The players in the fifth car never mention any relation between the two events, but rather talked about them as separate incidences of the story. They instead interpreted the gunshot as if it was themselves that was being fired at, rather than one of the criminals.

Table 7. Excerpt from the dead body event in the 5th car

Time	*System output*	*Road context*	*Visual focus*
07:08	Children cheering at the sports ground	Passing a sports ground.	Emma looks at sports ground. William occasionally glances at it
07:28		Deceleration at red light	
07:34	Walkie-Talkie call	Standing still.	Switch between looking at screen and at sports ground
07:49	Agent: " we are on the other side of sports ground“	Car halts.	Look towards sports ground
07:55	Gunshot	Standing still.	Look towards screen
08:01	Choices		Looks at the screen
08:15		Accelerate, turns left.	

The car is driving beside a sports ground (07:08) and stops at a red light (07:28). The first event is triggered and a walkie-talkie call from a field agent is heard (07:34). The players are immediately looking in the direction the agent is referring to. The gunshot is heard (07:55) as the car drives away from the crossing (08:15). During the next part of the episode, the players were intended to use the directional microphone to find a specific physical location which would trigger further action. The interviews reveal that it was only the players in the fifth car (see excerpt above), which linked the story to a building that they had seen outside the window of the car. The other children retold the two episodes as if they were happening at one physical location, i.e. where the gun shot was heard, and never with any reference to a specific witnessed building.

None of the experiences in the test runs were as we intended. It was difficult for the players both perceive the events as part of a continuous story, while at the same time link each event to its intended physical location. The players either interpreted the two events as one comprehensive narrative taking place at one physical location, or as two separate events that were played out at two separate locations. It could simply be that it was to unintuitive to combine the story in these two events with separate physical locations. It is also possible that the referred building wasn't visible during some of game sessions. By analyzing the game-play it is possible to see other factors that might have a contributing factor. The excerpt in table 7 reveals that the fifth car (see table 7) is standing still when the event is executed, which was never the case during any of the other players' test session. For the players in this car the story here got a different meaning. Instead of interpreting the gunshot as if someone else was being shot, they interpreted the situation as they themselves were attacked. By making this interpretation of the incident it is not so surprising that the players did not link the gunshot to the dead body found during the next event. It is therefore possible that the actual speed of the vehicle could have an important influence on the interpretation of the actual story itself. A player that is standing still might feel more exposed and vulnerable than if the car is rolling. In this way physical movement might contribute to a feeling of confidence. When there is less movement, the player feels more vulnerable. We can conclude that there were several factors that might have influenced the apprehension of the narrative, but that all the players in the end still managed to create their own comprehensible understanding about the incident and its significance to the overall storyline.

Pacing of events: The speed of the vehicle affect the pacing of game events. Currently the game engine selects locations mostly with regard to availability. The speed of the car decides how long time it takes to reach the selected locations. The system only compensate for long delays by adding non localized game materials. The pacing differed across the different test sessions due to the varying sequential order of the game events. The average time between the events was 1.44 minutes It was sometimes shorter due to frequently appearing objects of interest for the game and sometimes longer due to game pacing or lack of content to execute. The players responses in the questionnaire indicates that the pacing was somewhat slow (10,11). However, the MfM-interviews revealed that some of them approve of it and others reject it:

Steve: I mean, it is long… there are periods when nothing happens, but then suddenly everything happens at the same time, you have to be patient and then be able to work fast.

Journalist: What is boring with your job as a field agent manager? You mention that it becomes tedious, or...

Steve: No there is just long moments when there is not so much happening and then suddenly there is gunfire and everything happens at once. You just have to be patient. That's also something positive.

Pacing was in two of the interviews mentioned as something positive. Having to patiently wait for something important to happen and then be ready to act quickly was seen as part of an agent's job. However other players were more critical:

William:…it would need some more action.

Journalist: Okay, a bit more action.

Emma: It was really fun when there was a lot of action, when there were a lot of walkie-talkie calls and Helena

Summing up, pacing is of some importance for the experience. But it is currently difficult to tease out the detail ways in which it works.

Discussion

The study reveals that the players' movements, i.e. velocity and direction, affected their interaction with the physical landscape in multiple ways. The movement affected both how they experienced and practically oriented themselves, towards the surrounding. In order to design novel context-dependant applications for mobile use contexts we need to look beyond movement only as a navigation topic. Instead, movement should be regarded as an important design parameter in the emerging areas of mobile spatial interaction and location-dependant games.

The excerpts showed how the general concept of blended focus of attention, i.e. spatial interaction providing a visual experience of the surrounding landscape at the same time as experiencing it through digital media, was actually pursued in four different way. We termed these techniques: synchronized orientation; aural orientation; visual orientation and skewed orientation. Basing the interaction on the directional microphone metaphor we initially expected something like synchronized orientation, i.e. that hand and eye movement would be constantly aligned while interacting with the physical surrounding. For most players this was initially true in the beginning. But as the players got more familiar with the game play, the interaction technique changed. The most obvious change is the disconnection between hand and eye movements. From this new behavior two notable interaction techniques emerged, namely aural orientation and visual orientation. Towards the end a forth technique, referred to as skewed orientation, was observed, consisting of a combination of the two earlier techniques used in an unsynchronized manner. However, in all these examples we can still observed how the players manage to maintain a blended experience by quickly aligning their visual sight with the direction of the device once an interesting sound or visual object was found. While this way of interacting might be a bit unexpected at the beginning it makes sense if we consider the players speed and uncontrolled movement. Due to high speed object pass by in a rapid flow. By splitting the visual focus and the hand movement they managed to cover more ground in the search for game events. We conclude that high speed causes shorter moments of alignments but that a blended experience was still attained as soon as either an object or a sound caught the player's attention.

We also identified how variations in speed affected the choice of orientation methods. We initially expected a greater interest in spatial details and hence, a prolonged orientation aligned towards individual objects such as displayed in simultaneous orientation. This behavior also occurred rather frequently as soon as the car slowed down. Accordingly, the players adapted their visual focus of attention very much in accordance with the speed.

The interviews reveal that the players mostly referred to large sized objects, such as lakes or forest. They seldom mentioned smaller objects such as buildings. This could be due to various reasons such as technical deficiencies, occlusion, the way the sounds were applied or the players' capacity of remembering different types of objects. Possibly it could also be the case that they saw the intended objects, but that the swift movement made small scaled objects visible for such short duration and only very incomprehensible that it became hard to remember them. Hence, our particular design did not change the cursory experience in that sense, while large scale objects provide more time for identification and interaction. If the result is due to the swift movement, and not from a failure of a precise spatial mapping, the design would consequently benefit from a more extended use of large scaled objects. At this point, however, we can not specifically refer the observation to any of the above the accounted factors.

The sequence of game events differed in all of the test sessions. Regardless, the players made sense of the different episodes as part of the overall narrative. However, the players occasionally had difficulties to associate fictive content to several sequentially appearing locations, such as hearing a gunshot at one location and then associate the executed act to a location appearing somewhat later.

The movement also contributed to variations in the pacing of game events. The pauses in between the events felt as monotonous by some players. However, other player also made it clear that being patient and ready for sudden action was part of the job as an agent. Accordingly, the theme of the game, i.e. the crime mystery genre, made an uneven and sometimes suspended pacing acceptable.

The study indicated that the speed influenced how the players apprehended the game story and hence also the overall sequential experience. When the vehicle was standing still during an intense moment in the game, the players' interpretation of the event differed compared to moving players. It appeared as if a lack of speed made the player feel more exposed and vulnerable than if the car was rolling. Thus, that high speed contributed to a feeling of confidence where the player felt more in the role of an observer, while standing still suddenly would turn the player into a victim.

As discussed earlier, speed causes a cursory experience of the landscape, which is a form of detachment between the passenger and the passing objects. But by applying enable transparency and transformation through spatial interaction, we manage to keep the player engaged in the roadside and its objects. The speed however still causes this engagement to be strained. Consequently, the players struggle to keep up with things causing them to invent new interaction strategies to cope with the situation. This could in some cases be interpreted as bad interaction design but from a game design perspective however it is not necessarily negative. All, except from one, players answered that they really felt that the game was going on outside the window (table 5, question nr. 6) and many afterwards had problems distinguishing what they saw for real and what was perceived through the game device. The game in other words provided a very immersive experience. We argue that this is a direct result of the motion. According to Björk et al, immersion occurs when you combine difficult sensory-motorical tasks as well mental task (Björk & Holopainen, 2004). In other words while speed generally causes detachment from the outside reality, it in our case, at the same time caused an immersion into our twisted reality. It follows that the way we account for movement in spatial interaction is not just to upheave the cursory experience, but find ways to balance transparency and transformation.

Conclusion

The study reveals that users' physical movement through a landscape has consequences both for the way they practically interact with it, as well as the way they experience the environment. We have shown how this aspect of social life is both a constraint for interaction with mobile devices, but also a very interesting resource in game design. High velocity, adds to the research area of mobile spatial interaction, since it creates an interesting experience to draw upon, but also requires new solutions to recognized problems. Furthermore, Harrison and Dourish (Harrison & Dourish, 1996) established a concern for the ways in which geographical structures constrain and enable certain forms of movement and interaction. Our study invite to further investigations on the opposite question on how physical movement affects interaction with computers and geographical environments, and especially the hard cases where the users lack control of their motion. Those situations are in no way socially marginal, but occur on a daily basis in a modern mobile life. We believe that physical movement should have a high priority, when location based spatial interaction is considered.

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